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Plate XXVIII.–XXXVI. Illustrating paper, "Observations on the Plankton of Puget Sound."

He reported finding a formation that was a connecting link between the close of the Cretaceous and the beginning of the Tertiary. He gave an interesting account of the massive ruins of the so-called cliff dwellers in the region visited. In the Big Horn Basin the expedition had remarkable success as well as in the Wind River basin.

Prof. Osborn stated that with the collections made this summer the American Museum could now announce that their Eocene collection was complete, containing all mammals now known in the Eocene; that their collections from the Wasatch beds were the finest in existence and that from the Wind River basin were complete. The Bridger was represented by all but two or three types, and fine collections had been made in the Uintah.

Mr. W. J. Hornaday made a report of his recent tour of inspection of foreign zoölogical gardens, performed under the auspices of the New York Zoölogical Society. He visited fifteen gardens in England and on the continent, studying the features of excellence in each.

The report was discussed by Messrs. Osborn, Britton and Dean.

At the request of the chairman Prof. Bristol gave a brief account of the progress at the Marine Biological Laboratory at Wood's Hall, Mass., during the past summer.

Prof. Osborn offered the following resolution on the death of Prof. G. Brown Goode, after paying a tribute to his memory:

*Resolved*, That the members of the Biological Section of the New York Academy of Sciences desire to express their deep sense of loss in the death of Prof. G. Brown Goode, of the U. S. National Museum. In common with all naturalists in this country, we have admired his intelligent and highly successful administration of the National Museum, as well as his prompt and ready response to the requests and needs of similar institutions throughout the country.

In face of the arduous and exacting duties of his directorship he has held a leading position among American zoölogists, and we are indebted to him for a series of invaluable investigations, especially upon the fishes.

Those of us who had the good fortune to know Prof. Goode personally, recall his singular charm of character, his genial interest in the work of others and his true, scientific spirit. We have lost one of our ablest fellow-workers and one of the truest and best of men.

The resolution was adopted unanimously by a rising vote.

The Academy then adjourned.

CHARLES L. BRISTOL,
*Secretary of Section.*

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STATED MEETING.

October 19th, 1896.

The Academy met and was called to order by the Secretary.

In the absence of the President and Vice-President, on motion Dr. N. L. Britton was nominated and elected Chairman.

The Section of Geology and Mineralogy at once organized.

The minutes of the last meeting of the Section of Mineralogy and Geology were read and approved.

The first paper of the evening was the following:

## GEOLOGICAL NOTES.

## LONG ISLAND AND BLOCK ISLAND.

[Illustrated by maps, charts and specimens.]

BY ARTHUR HOLLICK.

In my previous investigations on Staten Island, Long Island, Martha's Vineyard and Nantucket, I became convinced that a unity of conditions prevailed throughout, and that by careful and systematic work a sufficient number of facts would eventually be accumulated to prove this beyond any reasonable doubt. Accordingly, year by year, one locality after another was visited, observations were carefully recorded and a large amount of material was collected. The facts, and the conclusions deduced

border to an almost complete replacement of the rutile. The mass of titanite, which results from this alteration, is not made up of a single crystal as is the case when it occurs as an original constituent, but is composed of minute grains closely compacted together.

Riess and Zirkel mention olivine as being present in some of the rocks, but the writer was unable to identify it in any of the slides, although they represented the different localities where it was said to occur and special attention was directed upon finding it.

It would seem, however, that Riess has confused it with titanite. In his description of its properties, he says: "In all the above hornblende-garnet rocks olivine is present in large quantities. The olivine occurs as dirty white grains. The appearance of these grains in the form of opaque particles crowded together, or of a zircon crystal lying in the middle of the grain is frequent. The chromatic polarization of the olivine is weak." While the optical properties of the two minerals are quite distinct, the forms which the titanite or titanomorphite assumes, often bear a rude resemblance to those of olivine, and this fact may have lead to the mistake in identifying them.

Quartz was found in some of the slides and was absent from others. While often an original constituent, in some cases its presence is due to later infiltration.

Feldspar is seldom if ever found in the omphacite rocks, but accompanies hornblende and may then occur in considerable quantities. It is a plagioclase whose extinction angles indicate andesine.

Other less common minerals are muscovite, pyrite, pyrrhotite, magnetite, apatite, calcite and zircon.

Macroscopically the eclogite has generally a massive appearance. Though occasionally a well-defined parallel arrangement of the different minerals can be detected, it never assumes the schistosity of the surrounding gneisses.

A peculiar structure which many of the slides exhibit arises from the intergrowing of pyroxene, hornblende and feldspar giving an effect not unlike that to be seen in the granophyric intergrowth of quartz and feldspar in the acidic eruptive rocks. Oftentimes their more or less irregular arrangement of the grains gives way to a radial arrangement about some pyroxene or garnet crystal. The latter is then generally surrounded by a dense, grayish colored rim, not unlike kelyphite in its appearance, which under high powers resolves itself into an aggregate of feldspar, hornblende and omphacite.

The chemical composition of the eclogite is somewhat vari-

able; the amount of silica varying considerably as we would expect from the irregular appearance of quartz.

ANALYSES.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $SiO_2$ | 57.10 | 55.00 | 48.81 | 58.82 | 47.60 |
| $Al_2O_3$ | 11.66 | 13.54 | 16.25 | 10.17 | 15.29 |
| $Fe_2O_3$ | 2.84 | 2.74 | 6.00 | 5.05 | 7.09 |
| FeO | 3.22 | 3.37 | 7.48 | 7.12 | 6.87 |
| MnO | 0.31 | 0.20 | 0.43 | | 0.12 |
| CuO | 13.80 | 12.09 | 9.72 | 10.27 | 8.41 |
| MgO | 6.37 | 10.21 | 7.12 | 4.00 | 6.48 |
| $K_2O$ | 0.81 | 0.50 | 0.46 | 0.68 | 1.40 |
| $Na_2O$ | 2.21 | 2.10 | 2.64 | 2.55 | 3.62 |
| $H_2O$ | 0.54 | 0.32 | 0.12 | | 2.14 |
| $CO_2$ | | | | 1.47 | 0.16 |
| | 98.86 | 100.07 | 99.03 | 100.13 | 99.18 |

1. Eclogite from Eppenreuth; by v. Gerichten; garnet, omphacite, disthene and quartz.
2. Eclogite from Silberbach; by v. Gerichten; garnet, omphacite, disthene and quartz.
3. Eclogite from Markt Schorgast; by v. Gerichten; garnet, omphacite and hornblende.
4. Quartz diabase from Przibram, Bohemia, by Dietrich.
5. Diabase from Fichtelberg, in the Fichtelgebirge, by Loretz.

Nos. 1 and 2 are poor in iron for such basic rocks, but otherwise agree quite closely with diabase (4). No. 3 contains little quartz and is richer in iron than the others, the latter being contained in the garnet. This analysis compares quite closely with diabase (5). In all these $CaO > MgO > Na_2O + K_2O$.

It is evident that as far as chemical composition is concerned the eclogite is identical with certain types of eruptive rocks. Closer comparison of the two is, unfortunately, impossible, owing to the lack of all transition stages and the great mineralogical differences, which cannot be fully accounted for in the present state of our knowledge concerning the subject of metamorphism.

The Academy then adjourned.

J. F. KEMP,
*Secretary.*

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STATED MEETING.

October 26th, 1896.

The Academy met with PROF. F. H. GIDDINGS in the chair. There were 30 members present.

Mr. H. Jacoby showed a micrometer ocular for measurements upon star photographs, its peculiarity being a double set of cross hairs at right angles to each other, so that both the co-ordinates of the star can be measured at the same time.

The Section then adjourned.

J. F. KEMP,
*Recording Secretary.*
WM. HALLOCK,
*Secretary of Section.*

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MEETING OF THE BIOLOGICAL SECTION.

November 9th, 1896.

The Chairman, Professor CURTIS in the chair. Seventy-eight persons present.

Members of the Columbia University expedition to Puget Sound made reports on the summer's work as follows:

After a brief introduction by Professor Osborn the papers were read in the following order: Mr. N. R. Harrington, "On the Organization of the Expedition and the work of the Port Townsend Laboratory," also "On the Echinoderms, Annelids and Arthropods of the Collection."

B. B. Griffin, "On the Platodes, Gephyreans, Nemerteans and Mollusks."

G. N. Calkins, "On the Protozoans and Cœlenterates.

Bashford Dean, "On the Vertebrates."

The papers were illustrated by lantern slides and by a number of the more interesting specimens.

The section then adjourned, C. L. BRISTOL,
*Secretary.*

These reports cannot as yet be presented for publication, but an outline of the work of the summer's exposition should, never-

theless, be given. Accordingly the following abstract has been prepared, based upon the above accounts by the members of the party.

## THE COLUMBIA UNIVERSITY ZOÖLOGICAL EXPEDITION OF 1896. WITH A BRIEF ACCOUNT OF THE WORK OF COLLECTING IN PUGET SOUND AND ON THE PACIFIC COAST.

The project of the Department of Zoölogy of Columbia University, to send an expedition to the waters of Puget Sound, had its origin in a visit to that region by Professor Edmund B. Wilson during the summer of 1895. Dr. Wilson had at that time undertaken a reconnaissance of the coast of the Pacific States in the interests of the University of California, which had then in view the location of a permanent seaside laboratory. The report which he brought back of the zoölogical conditions of the Pacific Coast, and of Puget Sound in particular, was in every way a favorable one: the fauna was rich, comparatively little studied and especially interesting to the morphologist or embryologist, and much valuable material could be secured with even the ordinary means of collecting.

During the early spring of the present year Professor Osborn brought the matter of a collecting trip to Puget Sound to the attention of certain members of the board of Trustees of Columbia and expressed his belief that the project was one which was well worthy of being fostered on the part of the University. By their aid over one-half the expenses of the expedition was subscribed; the remainder was met by its members.

By the month of April the organization of the party had been arranged: it was to consist of six members, and it was then hoped that Professor Wilson would be able to undertake the leadership; but his place was finally taken by Dr. Bashford Dean. The responsibility of the work of the party came, however, to be almost equally divided, Mr. Gary N. Calkins undertaking the collection of the Protozoa and Cœlenterata, Mr. N. R. Harrington the Echinodermata, Annelida and Crustacea, Mr. B. B. Griffin the Platodes, Nemertea, Mollusca and Insecta, and Dr. Dean the Protochordata and Chordata.

The chances of obtaining any material for the study of the development of a Myxinoid seemed, unfortunately, far less probable. This form, standing next to Amphioxus at the base of the vertebrate series, certainly promises to furnish the most important evidence as to the mode of origin of many vertebrate structures, if not indeed as to the ancestral conditions of vertebrates themselves. So desirable seemed a developmental knowledge of a Myxinoid, that many European embryologists during the past quarter of a century have endeavored to secure its younger stages (Myxine) at various points of the North Sea. On the Californian coast as many as five investigators have at different times tried to obtain its embryos (Bdellostoma). It was not until 1894–1895 that the embryo of a Myxinoid was first secured; its discoverer, Prof. E. C. Price, of the Leland Stanford, Jr. University, then succeeded in obtaining three stages, although these proved to be but the later ones.

When, therefore, Dr. Dean found that the neighborhood of Port Townsend was not favorable for the study of either Chimæra or Bdellostoma, he finally determined to leave the laboratory and journey further to the southward. Chimæra is, indeed, not uncommon in Puget Sound; it is, in fact, very abundant, but there were no fishermen who could be depended upon to provide it in quantity, and it was desired to secure the eggs while still within the fish and to hatch them in floating cases. To obtain the eggs already deposited by means of dredging seemed at first by no means impossible, for the egg capsules were dredged in numbers (as many in fact as eighty in a single day), but in no instance was an embryo to be found, in spite of continued efforts. As far as Bdellestoma was concerned, it was soon found absolutely impossible to attempt to secure this form in Puget Sound

Accordingly, at the end of three weeks' field work at Port Townsend, Dr. Dean left the party and proceeded to the neighborhood of Monterey, California, and here at Pacific Grove he continued his studies for upward of eleven weeks. He had been kindly invited by President Jordan, of the Stanford University, to occupy a room at the Hopkins Marine Laboratory, and had gratefully accepted his invitation. Once at Monterey, he soon was able to determine that the conditions were well suited to his undertaking. By means of the fishermen of the neighboring Chinese village he was enabled to take part in daily fishing trips off the coast, and to secure by means of his own and the remaining boats numbers of Chimæra, so that in the course of his stay he had the opportunity of examining over three hundred. Of these fish, thirty of the females proved to be with

eggs, and among them were obtained the earliest stages of development. For the later stages the eggs were retained in a case sunken in about three fathoms of water immediately off the beach of the laboratory, and from these several more stages were later taken. Ill fortune, however, overtook some of the eggs which had incubated the longest, a storm causing the hatching case to be swept away. And still another stroke of ill fortune was the loss, in spite of additional precautions, of a second case of eggs, which Dr. Dean had left in charge of the fisherman Ah Tack Lee. But still a third one is now stocked with eggs, and from it he hopes that many of the later stages will be obtained.

As far as the securing of embryos of Bdellostoma was concerned, the chances seemed for a long time adverse. For upward of eight weeks of his stay Dr. Dean did not succeed in obtaining even a single embryo. Several times strings of eggs had been brought him by the fishermen and he had collected them himself, but in every case they proved to be worthless. The eggs, it was found, could only be taken by accident in the following way: The mature Myxinoid, having taken a hook of the trawl line, secretes an enormous quantity of thick and viscid slime, and if by chance during this process its writhing body comes in contact with a string of eggs these may become enslimed, and thus, together with the fish, be brought to the surface. Such an accident, it may readily be understood, is decidedly uncommon, and the capture of a bunch of eggs means the catching of scores or even hundreds of Myxinoids. By good fortune, however, the first embryo was at last taken by Ah Tack, and thanks to this skilful fisherman the particular spot was located from which this had been taken. Here, it was inferred, was possibly a favorable spawning ground where eggs were both numerous and contained embryos, and therefore from this spot it was very desirable to take as many Bdellostoma as possible. An arrangement was accordingly made by which the dozen or more fishing boats of the Chinese village were impressed into zoölogical service. This little fleet was then taken to the ground and during the remainder of Dr. Dean's stay its efforts in trawling yielded the best results. Over seven hundred eggs were taken for inspection and of these no less than one hundred and fifty proved to contain embryos, and these when more carefully examined yielded at least twenty-two well-marked developmental stages.

The collections of material, chordate and non-chordate, made by the western party have been safely received at the laboratory of the department of Zoölogy, and have there been assorted and

**c** parallel to **c** of plate. Then there will be a phase difference and resultant color due to the sum of the phase differences of crys-

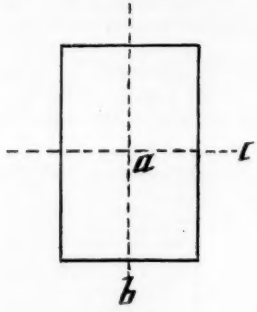


FIG. 5.

tal and gypsum. If now there is a rotation around **b**, the phase difference will change, because **c** will vary from **c** to **a**, and at some point, which will be the point of emergence of an optic axis, the phase difference of the crystal will be zero, that is, **c** = **b**, and the color will be the red of the gypsum. With further rotation **c** will be greater than **b**, and the red color will be lowered.

With a rotation around **c** there is no such change, for throughout the elasticity in the direction **b** is the greater.

In sections approximately normal to **c**, in corresponding posi-

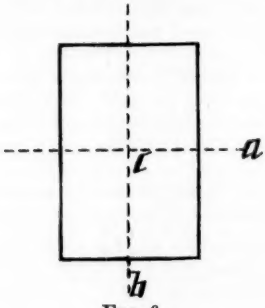


FIG. 6.

tion, the rotation around **b** produces a similar change from ascending to descending, with a turning point or emergence of axis where the color is the red of first order, *i. e.*, **a** = **b**. With rotation around **a** there is no such result.

It may therefore be concluded from the behavior of the section normal to **a**. *First* by the reversal of the relation of phase differences during rotation around one of the extinction directions that this direction is **b** and the other **c** and similarly with the section normal to **c** it may be proved that the axis of rotation is **b** and the other **a**. *Second* by rotation as far as the turning point where the red of first order is re-established the angle between an optic axis and the plate normal may be measured from which the character results from the rule that when the acute bisectrix is **c** the sign is positive.

## IV. The von Federow Mica Wedge.*

This is a simple inexpensive apparatus which can be used with even greater ease than the quartz wedge either to determine the character of the double refraction or to measure its strength.

The wedge consists of fifteen superposed quarter undulation mica plates, each about two mm. shorter than the one beneath it and with their axes of elasticity parallel. The series is mounted on a strip of glass and covered with a cover glass.

The wave length of a middle color may be taken as 560 $\mu\mu$ (millionths of a millimeter) hence each quarter undulation mica plate may be considered to possess a phase difference of 140 $\mu\mu$. If then between the polarizer and analyzer we insert the mica wedge so that its axis of least elasticity is at right angles to that of the mineral under examination, we subtract from the phase difference of the mineral an amount equal to $n$ times 140 $\mu\mu$ in which $n$ represents the numbers of superposed mica plates in the field. When the mineral appears dark the value evidently corresponds closely to the phase difference of the mineral.

From the expression $\Delta = eX$. in which $\Delta$ is the phase difference, $X$ the double refraction, and $e$ the thickness in millionths of millimeters, the thickness can be deduced when the double refraction is known or *vice versa*. If a mineral of known double refraction can be found in the section near the mineral under investigation† the double refraction of the latter can be deduced by measuring the phase difference of the known mineral whence

* E. von Federow *Zeit. f. Kryst, etc.*, v. 25, 1895, p. 349.
† It is not safe to use minerals near the edge of the section as the thicknesses are apt to be unequal.

relations of this puzzling fossil and in throwing light upon a primitive mode of spine formation within the phylum of fishes.

In the first regard to return to the puzzling question * as to what portion of a fish Edestus represented. Accepting as a logical necessity that the fossil is elasmobranchian, the choice of its location cannot be a wide one: it must have belonged either in the mouth region or on the body surface, in the latter case evidently as a spine. As to its belonging in the mouth region the segmented nature of its base has ever precluded the view that it was in any way connected with meckelian or palatoquadrate structures. And as an intermandibular element its position is even less plausible. For in the first place such a view would require *E. lecontei* to be the generalized rather than the most specialized of the different types. And one would have to assume that this intermandibular, which in the only teleostome in which it occurs is in its basis a dermal structure, has not merely been paralleled by the far different jaw conditions of an elasmobranch, but has been paralleled in a cartilaginous tissue. Moreover, even granting the possibility of this, the comparison with an intermandibular element could not yet be made, for in Edestus the shaft is segmented, and in Onychodus its basal portion is unquestionably a single piece.

If Edestus must now be excluded from the structures of the mouth region, it would accordingly fall within the broad class of spines. And this is the alternative which at the present day is very generally accepted. But what manner of spine could it have been? On account of the segmented character of its shaft Henry Woodward has compared it to the pectoral spines of the Teleost *Pelecopterus*. Newberry on the other hand, reviewing its characters in an extended memoir, decides with the clearest and most convincing arguments that the spine was a median one, that it was deeply implanted in the integument and that no fin structures could have existed behind it; it was therefore comparable to the spine series of the sting rays, and its position accordingly might reasonably have been in the hinder trunk region. But even this conclusion does not seem to the present writer altogether a final one. For in *Trygon* the spine series is apparently compound, while in Edestus, the spine, although segmented, is nevertheless a single one. There is, in other words, no common spine shaft in the sting ray from which the denticles take their origin. To make this comparison tenable it must, therefore, be assumed that the individual element of the spine series of *Trygon* represents a segment of Edestus. Of course

* Cf. especially the views of Hitchcock, L. Agassiz, Henry Woodward and Newberry, Newberry, *op. cit.*

Dr. Newberry never intended to establish definite homologies between these two spines, far less suggest for a moment that there was genetic relationship between them, for the phylogeny of the widely divergent types of rays is too perfectly known to admit of the possibility of their tail spines being a primitive character—any more in fact than the lateral tail spine of *Acanthurus*. His suggestion was merely that the spine of Edestus might be located " in the position of the second dorsal fin on the back or tail of a plagiostome fish (op. cit. p. 9.)."

But the series of forms above described gives us now a somewhat more definite groundwork for a study of the relationships of Edestus. As a flattened spine (*E. heinrichsii*) it bears evidence of having been so imbedded in the integument that a straight row of enlarged shagreen denticles alone protruded above the surface. Each denticle with its underlying basal segment would thus be interpreted, as the present writer has already suggested,* as a metameral element, each denticle with its secondary cusps representing the sum of the shagreen papillæ occurring in a particular region (median dorsal?) of a metamere, its gouge-like underlying portion the fusion of the bases of these denticles. From these conditions the spine has advanced in its path of specialization, becoming more decurved until finally it assumes a hook-shaped outline. Its hinder end tends at the same time to become differentiated, and in the narrow end of the shaft in *E. lecontei* no trace of segmentation can be determined.

From its distinctly metameral character, as shown in the simpler types, Edestus is certainly to be given a very primitive rank among ichthyodorulites wherever its position may have been. That a large portion of its basal elements was inserted in the integument seems exceedingly probable for all forms, and in this event the curved spines must have been placed either upon the summit of a fleshy, rounded ridge, or within a trench as an erectile spine—the latter doubtless less probably. It is at this point worthy of note that the narrow end of the shaft of *E. lecontei* bears no trace of segmentation. Can this be interpreted as evidence that the hinder end projected above the body surface? In any event does the present evidence gainsay the thesis of Newberry that the spine is bilaterally symmetrical and must, therefore, have found its place in the median line of the body? As far as the writer is aware, all evidence is in favor of this view; no specimen can be pointed to as showing definitely traces of asymmetry. But, on the other hand, it cannot be doubted that this bilateral condition might have attained in spines which were not strictly in the median line. In view of

*Fishes Living and Fossil, pp. 28–30.

the peculiar terminal of the new species of Edestus, one cannot at present help feeling that its position may have been somewhere on the head region, perhaps above or behind the eye in some early type of Cestraciont. For it is certainly more natural to place Edestus within a group of known spines than to attempt to create for it a station by itself. In the former case the evolution of the remarkable head spines would receive a plausible, if not probable, solution. Beginning with the simplest type of Edestus, situated, doubtless, far back, within the metameral conditions of the anterior muscles of the trunk, the spine has increased in curvature, at the same time tending to occur further and further forward.* A degree of asymmetry may next have appeared, and the peculiar forms of *Listracanthus* and *Erismacanthus* may have culminated the series. At all events this is a suggestion which appears to be offered by the present comparison of the forms of Edestus.

The further conclusion afforded by the present comparison bears upon the problem of the origin of spines in primitive gnathostomes. Or, to be more accurate, upon one mode of spine origin, for everyone would be inclined to admit that there may have been several. In the present case the evidence may be accepted as conclusive that a spine-like organ had its origin as a metameral structure whose basal portion lay within the integument, and traversed longitudinally a number (seven at least) of body segments. And that from this condition arose a more or less typical spine shaft, thick at one end and pointed at the other, with indications that its decurved character was accompanied by a firmer insertion of the proximal end, and the eversion of the pointed tip. In this event it is but reasonable to assume that the principal difficulty in accounting for the origin of a spine has been overcome, for we have in Edestus the actual stages in which a horizontal structure belonging peculiarly to the body wall has become so decurved that its proximal end is certainly well nigh vertical. And when once a structure has been evolved which is evidently spine-like, one must admit that the straightening and lengthening of its shaft—processes accompanied by the fusion of the segmental elements and the shortening of the basal line of insertion within the integument—and its perfected dermal encasement and ornamentation become relatively at all events matters of secondary importance. In other words, the present writer is led to believe on the evidence of the spine series in Edestus that the origin of many of the dorsal and head spines of the early gnathostomes, the Ces-

*This tendency is well known among fishes, *e. g.*, *Pleuracanthus*, *Chimaeroids* and many teleosts, *Lophius*, *Trachypterus*, *Bregmaceros*, *Pataecus*, flat fishes.

tracionts and Trachyacanthids (Jaekel) in particular, may be traced to segmental structures in which the elements of the shagreen denticle have taken the principal formative part.*

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STATED MEETING.

November 23rd, 1896.

The Academy was called to order by Professor F. H. GIDDINGS, chairman of the Sub-section of Philology which immediately organized. Twenty-eight persons present.

Professor J. F. Kemp acted as secretary in the unavoidable absence of Professor Jackson.

The minutes of the last meeting, May 25, 1896, were read and approved.

A communication from Professor Jackson explaining his unavoidable absence was also read.

The first paper of the evening was by Professor H. A. Todd, entitled "The Epithet 'Magnus' as applied to Albert the Great" (Albertus Magnus).

The second paper of the evening was by Professor Calvin Thomas, and was entitled "Considerations on the Origin of Poetry."

The third paper of the evening was by Professor L. A. McLouth, and was entitled "A review of Eugene Wolff's Geschichte der deutschen Literatur der Gegenwart."

The fourth paper was by Professor Gillett of New York University, and was entitled "Remarks on the Summer School under the auspices of the Alliances Francaises."

Professor Price presented the name of Dr. E. G. Sihler, Professor of Latin in New York University, as resident member.

The Academy then adjourned.

J. F. KEMP,
*Acting Secretary of Section.*

*A second, although kindred, method of spine formation has been referred to in this connection (*Fishes, Living and Fossil*, p. 28). The concrescence of the fin supports in the anterior margin of the fin with a stout sheathing of shagreen denticles, may reasonably have produced the spines of Acanthodians (cf. *Anat. Anz.* vol. xi., pp. 673-679, 1896).

The above plan, with minor individual variations, is found to prevail throughout the series of cynomorphous monkeys examined.

The chief point of difference to be noted, in comparison with the usual human arrangement, is the absence of a separate branch from the Second and Third Cervical nerves, constituting the human Occipitalis minor. The deficiency of this nerve is made good to the cutaneous distribution of the lateral occipital and mastoid regions by the large size of the Auricularis magnus and the extensive distribution of the Occipitalis major.

The communicating twig from the Second Cervical to the Spinal Accessory (Fig. I., 4) may represent the rudiment of the human Lesser Occipital nerve. In Man this nerve is regularly derived from the loop between the Second and Third Cervical nerves, exceptionally entirely from the Second. The Occipitalis minor supplies a communicating branch to the Spinal Accessory. Possibly this communicating branch represents the element contributed by the Second Cervical nerve to the Occipitalis minor of the human plexus, the remaining cutaneous branches of the nerve being derived from the Third Cervical. In the Cynomorpha the corresponding branches remain isolated, not uniting to form a Lesser Occipital nerve. The branch from the Second Cervical nerve (Fig. I., 4), passes directly to the Spinal Accessory as a communicating branch, and the usual cutaneous distribution of the human Lesser Occipital is derived from the Third Cervical through the path of the Auricularis magnus.

The Occipitalis minor in Man also supplies, in addition to the terminal post-auricular distribution, cutaneous filaments to the narrow dorsal integumentary zone of the cervical plexus, occupying the interval between the adjacent margins of the Sterno-cleido-mastoid and Trapezius muscles. These tegumentary branches are either derived from the main nerve, or from a N. occipitalis minor secundus, if such a branch is present.

In the Cynomorpha the region in question is occupied by the Levator claviculæ (Omo-cleido-transversarius) or by a Cleido-occipital muscle, a link between the Sterno-cleido-mastoid and Trapezius. The overlying integument receives numerous branches from the Third and Fourth Cervical nerves, for the most part derived in common with the muscular branches to the Levator claviculæ and the adjacent deeper divisions of the Trapezius.

The communication of the Third Cervical nerve with the Spinal Accessory in man usually takes place by means of a twig passing to one of the Sterno-mastoid branches of the Accessory. By means of this communication filaments from the Third Cervical nerve pass both peripherally into the Sterno-mastoid branches of

the Accessory, and centrally into the main trunk of the Accessory, the ultimate destination of the latter being unknown.

The usual communication of the Third Cervical with the Spinal Accessory in the Cynomorpha is seen in the plexus of *Macacus rhesus* (Fig. I., 5).

Another form of the anastamotic connection between the upper cervical nerves and the Spinal Accessory is presented by the plexus of *Macacus pileatus*, Plate VI., (Fig. II.), also throwing some light on the probable derivation of the human Occipitalis minor.

Here the Third Cervical gives off, in addition to the Auricularis magnus (Fig. II., 1), and the two divisions of the Superficial Cervical (Fig. II., 3, 3′), a communicating branch of considerable size (Fig. II., 2), which passes in great part into the Sterno-mastoid branch of the Accessory (Fig. II., 5), travelling centrally within the sheath of the nerve. The remainder of this branch applies itself in two filaments to the main trunk of the Accessory, accompanying it in a peripheral direction, for a short distance. It then separates again from the main trunk of the Accessory, and, after junction with an additional filament from the Third Cervical, forms a trunk (Fig. II., 4), which supplies cutaneous filaments to the integument over the interval between Sterno-mastoid and Trapezius (Levator claviculæ). Considering the composition of this anastomosis in comparison with the human plexus we find the usual communication, with centrally directed fibres, between the Third Cervical nerve and the Sterno-mastoid branch of the Spinal Accessory.

The structure and distribution of branch 4 (Fig. II.), indicates a rudimentary Occipitalis minor. This supplies a second communicating twig to the Accessory—the fibres passing in a peripheral direction—and the tegumentary nerves to the dorsal zone of the cervical plexus, corresponding to the interval between the Sterno-mastoid and Trapezius.

The superficial distribution of the cervical plexus in the Cynomorpha is exceedingly rich in terminal branches, anastomosing freely with each other and frequently forming loops. They are placed under cover of the Platysma, and reach the cutaneous distribution by perforating this muscle.

The general arrangement of these superficial branches is seen in Plate VI., Fig. III., representing the superficial dissection of the right side of the neck in a specimen of *Macacus pileatus*. The branches may be grouped under the following heads:

### I. Auricularis magnus.

The nerve forms a large trunk, curving around the dorsal margin of the Sterno-cleido-mastoid and ascending on the outer

FIG. IV.

Plan of distribution of N. Auricularis magnus and N. Cervicalis superficialis in *Macacus rhesus*.

1. Branch to integument of post-auricular and mastoid regions.
2. Cranio-auricular branch.
3. Branch to Cymba.
4. Branch to Ext. auditory meatus.
5, 6. Branches to integument of Parotid region.

C. II. Anterior division of Second Cervical nerve.
C. III. Anterior division of Third Cervical nerve.
*D*, N. Cervicalis descendens superior.
*D'*, N. Cervicalis descendens inferior.
*a*, Branch of First Cervical nerve, giving off :

1. *C*, centrally directed bundle within the sheath of the Hypoglossal.
2. *R. a. mi*, and *R. a. ma*, branches to Rectus capitis anticus major and minor.
3. *d*, and *d'*, branches to N. Cervicalis descendens.

*b*, Loop between First and Second Cervical nerves.
*e*, Loop between Second and Third Cervical nerves.
*F*, *F*, Ansa cervicalis profunda, formed by N. Cervicalis descendens superior (D) and inferior (D').
*g*, Branch of Second Cervical nerve passing to peripheral distribution of Hypoglossal.
$F^1$, $F^2$, Branch of Third Cervical passing to peripheral distribution of Hypoglossal.
*Thy. hy*, Branch to Thyro-hyoid muscle.
*Gen. hy*, Branch to Genio-hyoid muscle.
*Om. hy. ant*, Branch to anterior belly of Omo-hyoid muscle.
*St. hy.*, Branch to Sterno-hyoid muscle.
*St. thy.*, Branch to Sterno-thyroid muscle.
*Om. hy. pos.*, Branch to posterior belly of Omo-hyoid muscle.

FIG. V.

Plan of Cervical Plexus and Ansa cervicalis profunda in man (after Holl).
XII. Hypoglossal nerve.
C. I. Anterior division of First Cervical nerve.

4. Branch to the dorsal zone of the cutaneous distribution of cervical plexus.
5. Branch to Sterno-mastoid.
6. Branches of XI. to Levator claviculæ and Trapezius.
7. Continuation of XI.

FIG. VI.

Right deep cervical ansa of the *Macacus rhesus*.
XII. Hypoglossal. = X. Vagus.
C. I. Anterior division of First Cervical nerve.
C. II. Anterior division of Second Cervical nerve.
C. III. Anterior division of Third Cervical nerve.
1 and 3, Branches of C. II. to the prævertebral muscles.
2. Branches of C. II. to Vagus.
*Thy. hy.* Branch to the Thyro-hyoid muscle.
*St. hy.* Branch to the Sterno-hyoid muscle.
*St. thy.* Branch to the Sterno-thyroid.
*Om. hy.* Branch to the Omo-hyoid.

FIG. VII.

Right deep cervical ansa of *Macacus rhesus*.
XII. Hypoglossal.
C. I. Anterior division of First Cervical nerve.
C. II. Anterior division of Second Cervical nerve.
C. III. Anterior division of Third Cervical nerve.
*Gen. hy.* Branch to Genio-hyoid muscle.
*Thy. hy.* Branch to Thyro hyoid muscle.
*St. hy.* Branch to Sterno-hyoid muscle.
*St. thy.* Branch to Sterno-thyroid muscle.
*Om. hy. ant.* Branch to anterior belly of Omo-hyoid muscle.
*Om. hy. post.* Branch to posterior belly of Omo-hyoid muscle.

FIG. VIII.

Right deep cervical ansa of *Macacus sinicus*.
XII. Hypoglossal nerve.
X. Vagus nerve.
S. Sympathetic nerve.
C. I. Anterior division of First Cervical nerve.
C. II. Anterior division of Second Cervical nerve.
C. III. Anterior division of Third Cervical nerve.
*Gen. hy.* Branch to Genio-hyoid muscle.
*Thy. hy.* Branch to Thyro-hyoid muscle.
*St. hy.* Branch to Sterno-hyoid muscle.
*St. thy.* Branch to Sterno-thyroid muscle.
*Om. hy.* Branch to Omo-hyoid muscle.

FIG. IX.

Formation of right Phrenic nerve in *Macacus rhesus*.
C. IV. Anterior division of Fourth Cervical nerve.
C. V. Anterior division of Fifth Cervical nerve.
C. VI. Anterior division of Sixth cervical nerve.
P. Phrenic nerve.
*Subcl.* Branch to Subclavius muscle.

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## STATED MEETING.

January 18th, 1897.

The Academy met with President STEVENSON in the Chair. About twenty-five persons present.

The minutes of the previous meeting were read and approved.

The Secretary then reported upon the possibility of a lecture from Sir Archibald Geikie, in coöperation with Columbia University, before the Academy next spring. On motion the matter was again referred to the Council with power.

The conglomerate occupies hollows in the limestone and extends to ten or twelve feet above the water, its thickness varying from one to six feet. It is made up of angular limestone fragments, much red material and badly broken shells of several marine mollusks. The overlying sandstone contains great abundance of *Helix*. The great quarries on the southerly side of Castle harbor, half a mile from Tuckertown bay, show the conglomerate at about the same distance above the water. The red portion is very hard, having been filled with calcareous matter by infiltration; the limestone fragments are angular, bluish and light yellow; the softer portions contain immense numbers of *Helix* and *Livona*, the latter rarely more than two inches in diameter. The mass is stalagmitic throughout and the lower portion of the sandstone has been united by infiltered material with the conglomerate. Another exposure on the property of W. S. Peniston shows the red rock filling pits in the limestone as red clay fills pits in the limestone and sandstone further up the hill, where it is from a few inches to almost twenty feet thick. The whole deposit here is from 0 to 10 feet thick and, as at the quarry, it includes the lower portion or *Helix* zone of the sandstone. Some portions of the mass, notably the top, are loaded with *Helix*, but *Livona* appears to be wanting. No marine forms, aside from *Livona*, were found at the exposures on this side of Castle harbor.

A knob of limestone reaches the surface in a road-cut near the Harrington house, where it is fifty feet above tide, and the red material with fragments of limestone resembles in all features except consolidation the present soil on top of the wall. *Helix* is abundant for about two feet above the red bed. A similar exposure beyond Paynter Vale at the east corner of Harrington sound shows the same conditions. Pear island, midway in Harrington sound, has limestone on its northwesterly side covered by the *helix*-bearing sandstone, which, on the opposite side of the island, passes below the water surface.

Contacts between sandstone and projecting knobs of limestone were seen at several places in Devonshire and Pembroke parishes, but no intermediate deposit was observed; these knobs may have been free from soil cover as are those projecting above the dune sands of to-day. The contact is well shown in the military road of Hamilton parish, where limestone and sandstone alternate, the latter evidently occupying hollows or petty valleys in the former. *Helix* was seen here but the red bed was not present at the three points examined.

The overlying sandstone must have accumulated very slowly in the beginning at most localities, as *Helix* occurs in extraordi-

nary numbers for a short distance above the red rock but usually is comparatively rare in the higher portions.

This deposit evidently passes the point of Castle harbor to the south shore of the island; the condition of contact is seen along the south shore on the Military road already referred to. At Devonshire bay, two miles beyond, is an interesting exposure to which both Rice* and Nelson have called attention. The succession is Sandstone, Marine Limestone, Limestone.

The intermediate deposit, or marine limestone, covers the broadly irregular surface of the limestone. It reaches to the water-level, on the southwest side of the old fort, but is seven or eight feet above it on the northerly side. The rock is hard in the lower portions, but becomes soft above, disintegrating readily and passing, as far as extent of consolidation is concerned, very gradually into the overlying deposit. It is slightly conglomerate in the upper portion. The structure is very similar to that of the sandstone, the laminæ being thin and inclined in all directions. The hardness of the rock is not due to spray, or to the washing of the present tides, since it is as marked on the northerly, as on the southerly side of the fort. *Livona*, *Chama*, *Tellina* and *Arca* occur in prodigious numbers, the shells of *Livona* being as large and as perfect as those dredged in Castle harbor, or in the shallows off the south shore. The other shells give equal proof of having been deposited in comparatively still water. On the southerly side of the old fort, an apparently complete physical break between the intermediate rock and the sandstone is indicated by a horizontal line, yet the passage from the lower to the upper rock is extremely gradual, while above the line and within the *Helix* zone, *Arca* and *Chama* were seen perfectly preserved, the open valves of *Arca*, in one case, being still attached. The condition, for a time at least, must have been such as one sees at Tuckertown to-day, where the dune is encroaching upon the bay.

An excavation in the sandstone, on the north side of the fort, reaching to this deposit, shows the former rock almost unconsolidated and holding great numbers of *Livona* in excellent condition; but it was not possible to determine whether or not these are above or below the *Helix*-zone.

On the road leading down to Hungry bay, a mile and a-half beyond Devonshire bay, the junction between the sandstone and the intermediate deposit is concealed, but the consolidated red material is shown precisely as at Peniston's quarry with the sandstone at a few feet above it. The *Helix* bed is concealed. The bluff at Elbow bay shows at eight or ten feet above the

*Loc. cit., p. 13.

Atlantic basin, "counterparts of the three great movements of the North American continent, which have characterized in American geology the epochs of the Quaternary age."*

Professor Heilprin's conclusions are:

1. The present form of the Bermudas bears no relation to the ring of an atoll, except in so far as the outer boundary may be more or less coincident with the boundaries of an ancient atoll. 2. The existence of an atoll in the present position of the Bermudas is not demonstrable. 3. The height of land in the archipelago was formed during a period of elevation, when seemingly the entire archipelago was a connected or continuous piece of land, extending as an oval island to what is now the bounding reef on the north and south. It is impossible to determine the absolute amount of elevation above the water, but it appears to have been not less than seventy or eighty feet and it may have been considerably more. 4. The lagoons and sounds were formed during a period of subsidence which followed upon that of elevation and is seemingly still in progress or was so until a comparatively recent period. The great degradation of the coast line took place at this time. It is impossible to determine the amount of such subsidence, but it was at least sixty or seventy feet and not improbably much more.†

Professor Heilprin argues energetically against the proposition that the sounds and harbors owe their origin to solution of rock supports and shows that instead of losing material by solution they are gaining constantly by deposits. He combats with equal energy the idea presented by Rein that the basins are due to "normal erosion assisted by the breakages which in one form or other are likely to follow the honeycombing of the rock."‡ He discusses the coral reef problem elaborately and defends the subsidence theory with decided emphasis, while he is careful to state that in using the term "subsidence" he uses it "in a relative sense indicating a depression or submergence of the land beneath the sea" without asserting "whether the submergence was due to a positive movement on the part of the land, or to a change in level (rise) in the water."§

Professor A. Agassiz's study was more in detail than that of any predecessor since Rice, and his discussions cover much ground untouched by any others. He regards the Bermudian rocks as æolian throughout, the limestone and sandstone as a continuous deposit, and cannot accept any identification of the fossiliferous rock of St. George, Hamilton harbor and elsewhere as beach

*Loc. cit., p. 18.
†The Bermudas, p. 46.
‡Loc. cit., p. 44.
§Loc. cit., p. 77.

rock, since marine forms have been found by Heilprin as well as by himself in rocks unquestionably æolian.* The so-called beach rock is at no higher elevation than if thrown up by a gale. On Ireland island it rests on æolian beds fifty feet below water mark.†

Respecting movements, he concludes that:

We need only a single subsidence to explain all the phenomena, if, as I have suggested, base rock is only modified æolian rock, and beach rock has been forming continuously, and the æolian hills were formed at the time when the atoll was one gigantic annular beach, constantly receiving fresh material from the outlying reef. This primordial reef has diappeared and its remnants exist perhaps at depths of twenty fathoms or more near the edge of the bank.‡

In view of all the facts, one cannot resist the conclusion that at one time the outer limit of the Bermuda land area was near the present twenty-fathom line. Whether or not the land originally was an elliptical reef enclosing a lagoon cannot be determined now and the character of the rock underlying the limestone can be ascertained only by a deep boring. The limestone itself is unquestionably of æolian origin, but it extends to a very considerable depth below water level, as is shown by the presence of huge stalagmitic columns, thirty feet below tide level in caverns between Harrington sound and Castle harbor and by the ascertained presence of the limestone itself in the excavations at Ireland island. The altitude, with relation to tide, must have been sufficient at one time to bring the floor of the caverns at least several feet above tide. As the extreme depth of Harrington sound as reported by Professor Heilprin is sixteen fathoms, the floor could hardly have been less than one hundred and twenty feet higher than now.

It is difficult to regard, without sharp limitations, the limestone as part of a continuous æolian deposit of which the sandstone and dune are the later portions, as Professors Thomson, Rice and Agassiz have done. That the formation of æolian rock has been continuous since land first appeared no one can doubt; but it is equally certain, as far as the present land area is concerned, that at one time and for a long time the accumulation of dune sands almost ceased or was confined to a narrow space along the shores. It is equally difficult to understand how the consolidation of the limestone could be due to the action of seawater, as has been suggested, for the rock is the same in the Ireland island

*A visit to the Bermudas in March, 1894, p. 228.
†Loc. cit., p. 224.
‡Loc. cit., p. 224.

Ceremonial Expression," and on the discussion following Dr. Brinton's and Dr. Boas' papers, as to the validity of the theory of the psychic unity of man in accounting for details of similarities in the mythologies of widely separated peoples.

LIVINGSTON FARRAND.
*Secretary of Sub-Section.*

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PUBLIC LECTURE.

January 29th, 1897.

The Academy met and were called to order by President Stevenson who introduced the lecturer of the evening, MR. H. G. PROUT, editor of the *Railroad Gazette*. The lecture was entitled "The Egyptian Soudan, its Recent History and the Campaign of 1896." Large maps were used in illustration. The speaker was heard with close attention and at the close of the lecture a vote of thanks was passed.

J. F. KEMP,
*Secretary.*

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REGULAR BUSINESS MEETING.

February 1st, 1897.

The Academy met with President STEVENSON in the chair. Twenty-four persons present.

The minutes of the last meeting were read and approved.

The Secretary presented the names of José M. Andreini, 29 West 75th street; Samuel Keyser, 14 East 36th street, from the Council, and on motion they were elected resident members.

There being no further business, the Section of Astronomy and Physics at once organized, Professor R. S. WOODWARD in the chair.

The first paper was the one postponed from last month, by

H. Jacoby, "On two Trail-plates of Circumpolar Stars, made by Anders Donner, at the Helsingfors Observatory."

It was explained that these photographic negatives of circumpolar stars were taken with the telescope stationary, so that each star left a trail upon the plate, which, after necessary corrections, would be an arc of a circle around the true North Pole of the heavens. The exposures which were for a few moments at intervals of half an hour, during a continuous period of over fourteen hours, thus gave a series of short arcs extending over a little more than a semicircle. This method, if no unforeseen difficulties appear, should give the position of the pole to within a few hundredths of a second of an arc, and a system of right ascensions differing from the truth by a uniform correction.

The paper was favorably discussed by the chairman and others.

The next paper was the following:

## INVESTIGATIONS OF THE UNDULATIONS IN RAILWAY TRACKS BY THE AUTHOR'S TRACK INDICATOR, AND THE REDUCTION OF TWO-THIRDS OF THEIR AMOUNT IN THE PAST FIFTEEN YEARS BY THE USE OF THE AUTHOR'S STIFF RAIL SECTIONS.

By P. H. Dudley.

If we stand by the side of a railway and notice the tracks as a train passes over them, we see, first, a general depression of the rails under the wheel base of the trucks or the locomotive, the greatest depressions being directly under the wheels; we further notice that the rails under the wheels bear more firmly on the ties, the latter depressing, and with instruments we find that the ballast and roadbed are also depressed.

We notice further that on either side of the wheels the surface of the rails is slightly higher, and if the wheel base is four or five feet long that the fibre stresses in the rails undergo a reversion and are of opposite character from those directly under the

without either the first or second forms of permanent set in the track; the rails appearing to the eye to have a smooth surface when not under the trains. I have designated such rails as the *fourth form*, representing the best condition of track, for they are in perfect service to the eye. For the trackmen's special benefit they will hereafter be designated as the fourth or proper form.

The undulations which remain in the tracks for the figures given are individually so minute, that at present they cannot be further reduced by the skilled trackmen. To reduce the undulations in the track to the low limits mentioned, it has been necessary to do a great deal of work which may be briefly summarized as follows:

First. To investigate the nature of the irregular undulations, and their causes.

Second. To provide rails with broad heads, which will distribute the wheel pressure to more metal for wear and side stability, and at the same time to have stiffer sections as girders in order to distribute the wheel loads to more ties and to greater area of ballast and roadbed.

Third. To distribute the metal in the sections so that the requirements of the second statement would be met, and at the same time to design sections that could be easily rolled, and that would permit of the introduction of a grade of steel of 50 per cent. higher elastic limits than the older rails, and that would still be hard, tough and not brittle.

Fourth. To go to the mills and carry out methods of manufacture suitable for the heavier sections as to composition, hot-bed treatment, and smoother finish under the straightening presses.

Fifth. To produce sections in which the final results would be better and more economical than those they replaced.

By the lantern slides and other diagrams I shall be able to show you that the limited undulations already stated for the sections have been realized on many hundred miles of track and that in the past fifteen years—principally the past eight—the undulations in many tracks have been reduced to one-third of their former amount.

During the same period, to meet the demands of service, the static wheel loads of the motive power and rolling stock have been increased. The freight car wheel loads have been trebled during this time.

I need hardly say to you that by reducing the undulations in the track to one-third of their amount fifteen years ago, the dynamic effects from the wheel loads have been reduced in a greater ratio, so that the combined static and dynamic effects

of the heavier wheel loads as distributed by the stiffer rails through the tie to the ballast and roadbed, are less than was the combined static and dynamic effects of the lighter wheel loads as distributed by the lighter rails through the tie to the ballast and roadbed. *The generation of an unnecessary and destructive force has been prevented.*

Every tie underneath the lighter rails received its load more in the nature of a suddenly applied blow than a gradually applied load, and its abrasion under the rails was very rapid.

As the cost of ties is now much greater than the cost of rails for renewals, the saving in expense for ties will be quite an item in paying for the stiffer rails. Treated ties can be now used under the stiffer rails, since the abrasion has been so much reduced.

There is considerable discussion as to whether the freight car loads should be reduced or increased. I find the tendency in the latter direction, as a number of cars of 80,000 pounds capacity are in use and others are building for loads of 100,000 pounds.

The freight car wheel load is now an international commercial matter and beyond the control of any one railroad company, just as is the freight rate per ton, but what is largely under the control of the company over whose lines the cars pass is whether the dynamic effect of the wheel loads shall be but a slight increase over the static load, or 50 to 100 per cent. greater to be transmitted to the ties, ballast, and roadbed, increasing the cost of transportation and maintenance of the equipment and permanent way.

One of the great objects to be obtained in permanent-way construction is to prevent the dynamic effects of the moving wheel loads of either the locomotives or cars from reaching much magnitude, for the effects of the static loads combined with the dynamic effects, when finally distributed to the roadbed, should always be less than its elasticity; otherwise the track cannot acquire any high degree of stability, nor be most economicall maintained.

The 80 and 100-pound rails are double and treble the stiffness of the former four and one-half, 65-pound rails, with much wider bearing surface for the wheels, and, as would be expected, the diagrams show that the waves of pressure from the wheel loads must be distributed over a much greater area of the roadbed, reducing their intensity to an amount more easily carried by the elasticity of the roadbed. The elasticity of the roadbed, though a very limited quantity, is a fundamental principle of maintenance of way, but it has received too little specific attention,

single afternoon from a point directly opposite the Indian school house in seven or eight fathoms of water. Thirty orforty *Holothuria californica* Stimpson were taken at the same time, three of which were infested with *Entoconchidæ*. Several enormous egg cases of the large skate *Raja ocellata* were brought up, some egg capsules containing two embryos each.

In Port Townsend Harbor there were dredged numerous specimens of *Pecten hastatus*. These, almost without exception, had the upper valve covered with an encrusting yellow or purple sponge. The Pectens were scarcely met with in any other locality.

Near Point Wilson, in about twenty fathoms of water, were found several hydroids. Possibly correlated with the paucity of the latter material is the fact that but three or four *Pycnogonida* were seen during the entire summer. *Caprella* is more than abundant in some districts about Hood's Canal. *Pennatula* was taken while fishing for *Chimæra* in Discovery Bay from fifty fathoms of water, also in shallower water by the dredge. The sea pen, *Verrillia*, is to be found in the same locality.

*Kilisut Harbor.*

This inlet, better known as Scow Bay, was oftener dredged than all the other places taken together on account of its proximity and unlimited resources. It shows several instances of restricted distribution, in the area covered on Puget sound, notably several transparent and one very large, orange-red tunicate, and the slimy-tube annelid *Siphonostoma*. This worm seemed to occur in a layer along the somewhat muddy bottom, for bushels of this jelly-like mass exclusively were brought up from a region half an acre in extent. As may be seen on the chart of the Hydrographic Survey, the depths and bottoms are very variable. This is further evidenced by the sharply defined faunal areas. The sandy hard bottoms furnish holothurians and crabs, and the shelly bottoms are covered with *Cynthia* colonies interlaced with *Spirographis* tubes. Two specimens of species *Synapta* were found here, two species of *Cribrella*, two species of *Solaster* and, in the shallower water, five fathoms, the four or five species of *Asterias*, common in littoral collecting, were dredged. Many small ophiurids of two or three types were gotten here, although *Ophioglypha* was found in twenty fathoms in Discovery Bay. Among the mollusca dredged in Scow Bay are one or two specimens of the large scallop *Amusium caurinum*, numerous *Cryptochiton stelleri*, whose papillose dorsum is always more or less covered with mud. This is to be contrasted with other *Chitons* dredged just

outside the mouth of the bay, such as *Mopalia*, *Katherina*, *Tonicella*, etc., which come up attached to stones, and always clean, indicating their habitat to be a clean stony bottom. *Gastropteron* and *Bulla* were thus obtained, a species of *Carinella*, and a large red dendrocœlous turbellarian, procured only by the dredge.

The rocky channel at the outlet of Scow Bay furnished two very interesting crabs. Here the tide runs very swiftly and only hardy or well protected creatures can find lodging. *Cryptolithodes* is a small crustacean with enormously developed lateral sides of the carapace. When clinging to rocks, his resemblance to *Chiton* or *Crepidula* is very striking. It is a rather rare crab, Stimpson's figure having been made from a single dried specimen from Monterey. A smaller type was gotten from Neah Bay.

*Marrowstone Point, Hood's Canal.*

Just south of the Marrowstone, the rocky and sandstone bottom is covered with Serpula tubes. The handsomest Serpula builds a hard white tube, while in dark colored tubes lives another variety with *Lepidonotus* and a bilateral hermit-crab commensal. We should also mention several white *Thyone*-like holothurians dredged here in the honeycombed sandstone.

The upper part of Hood's canal was found to be too muddy for successful dredging. Off Seabeck *Dentalium* was taken, but the principal denizen seems to be a small species of *Bulla*.

A large living *Balanus tintinnabulum* (?) with beak two inches in diameter was taken from the bottom of Port Townsend Harbor. Very probably it was scraped from the bottom of some ship lying at anchor here. An Octopus but ten or twelve inches long was taken off Marrowstone. Unfortunately it escaped before identification.

From various of the above named stations, the following mollusca were dredged: *Donax* sp., *Astarte* (two species) *Cardita* sp., *Cardium* sp., *Leda* sp., *Pectunculus subobsoletus*, P. sp., *Modiola modiolus*, *Placuanomia macroschisma*, *Eulima distorta*, *Eu.* sp., *Odostomia mucriformis*, *Galerus*, *Crepidula adunca*, *C. lingulata*, *Natica* and *Lunatia*, *Argobuccinum Oregonense*, *Olivetta bœtica*, *Pteronotus* sp., *Chrysodomus dirus*, *Trichitropis cancellatum*, *Bittium filosum*, *Magarita pupilla*, *Doto* sp., *Proctonotus* sp., *Elysia viridis*. Also *Terebratella transversa*.

With the exception of *Cardium* and *Lunatia* the above forms were found nowhere but in the zones reached by the dredge, *i. e.*, were not obtained in the littoral zones. Numerous empty shells and tests properly littoral come up in the dredge, *e. g.*, *Cardium*.

The first paper of the evening was by F. C. Nicholas, on "Explorations in the Gold Fields of Western Colombia." It will appear in the *School of Mines Quarterly* for April, 1897. The second paper of the evening was by Prof. R. E. Dodge, entitled "Recent Work in Physiography." Professor Dodge gave a brief review of De Lapparent's "Leçons en Geographie Physique;" of Sir John Lubbock's "Scenery of Switzerland," and of two recent papers by M. R. Campbell and C. F. Marbutt.

The paper was discussed by the Secretary.

The third paper of the evening was by Dr. A. A. Julien on "The Sculpture and Sorting of Sands." It was discussed by Professor Dodge and the Secretary.

The Academy then adjourned.

J. F. KEMP,
*Secretary.*

## THE MOUNTAINS AND TERTIARY VALLEYS OF EASTERN COLOMBIA.

Read December 21, 1896.

[WITH PLATE XV.]

BY FRANCIS CHILD NICHOLAS.

In asking your attention to a series of explorations and studies in eastern Colombia, I do not come claiming great knowledge as a geologist, or particular merit as an explorer; but to tell of what I have actually seen, thinking that it may be of some service. For, just as an able scientist, making researches in an unknown country, may ask superficial information from any who might be locally acquainted with the places to be explored, so my notes, gathered by personal investigation, may presently be of some service when abler minds begin to look about for information as they prepare to enter seriously on geological investigation in this part of South America.

The striking features in the country of which I write are these: The Sierra Nevada de Santa Marta mountains of crystalline formations, isolated and lying almost at right angles with the general axis of the Andes; the Cretaceous system found among the Andean ranges but a few miles distant; and the low

lying swamps and valleys evidently of Tertiary origin separating these two. (See Pl. XV.) Within a comparatively short distance, there are three distinct geological systems each non-conformable to the other, yet all in place very nearly as originally formed.

My mission was to investigate certain coal deposits found in the valleys, and claimed to be of true Carboniferous age, of the best quality and to be had in the greatest abundance. The work of exploration began at Rio Hacha, to the eastward of the Sierra Nevada mountains, a little seaport lying near the mouth of the Rio Rancheria. Here I found a broad flat country all sand and bush underlain by deposits of hard marls apparently of Miocene age. These prevented any vigorous growth of trees for a number of miles back from the sea and the country had a barren and rather dreary appearance.

After a short delay a start was made for the coal fields, a three days' journey, the route taking us across the sand deposits and through low wet places to the base of the eastern terminus of the Sierra Nevadas; then around this point and into a hot low lying valley. Here we followed the course of the Rio Rancheria to a point opposite a prominent peak in the eastern Andean extensions called the Cerrajon mountain. The valley was about twelve miles wide between the foothills of the Andes mountains on the east, and those of the Sierra Nevadas on the west. At some places it seemed as if this valley was almost at sea level.

The surface of the country appeared to be a recent alluvium marking old water courses, and the general upper strata seemed to be of well packed clay, shale-like at some places, with here and there surfaces of red iron bearing shales in thin strata, apparently a recent residue conformable to the irregularities of the underlying material; and scattered over the surface there were well worn boulders and gravels of Cretaceous limestone rich in fossils. This looked like a very recent formation, and I had seen fossils on the way up that had every appearance of being in place and of Miocene origin. I was deeply interested in the strange surroundings, but my faith in extensive coal deposits was a little shaken, although the remembrance of glowing reports made by others who had examined the country, and whose names I shall not quote out of deference to their opinions, soon restored my confidence.

The following day as early as possible I was on my way to look at the immense coal fields. The first showing was a disappointment, only a mass of soft decomposed material exposed between clay-like shales at a break in the surface, probably caused by the crowding and intrusion of ridges just beyond, or possibly by an uplifting of the whole mountain mass some two miles

Beyond the valley towards the sea there is a broad stretch of low flat country, much of which I should consider as having originated in the Quarternary period, because at various places near the coast I found deposits of sand containing modern shells, which could not have been formed by the waters of to-day. They were too far back from the sea and, moreover, in this district the land is now being washed away by the strong steady current setting along the coast from east to west. At the Rio Hacha one side of a long street with its stores and warehouses has been totally washed out, yet in the old Spanish days this was one of the most active and well-known places in South America, and the houses were of that substantial mason work, which was used in the last century, when strength was all important.

A further evidence that parts of the flat land between the valley of the Rancheria and the sea are of recent geological origin is the presence of human remains which are found under the most interesting conditions.

About three miles in a direct line from the sea the Rio Rancheria cuts against a steep bank of sand and alluvium deposits, which are about thirty feet high. When the river is very low three distinct strata can be seen. First the superficial, recent alluvium and sand about ten feet deep; below this a clearly defined stratum of coarser sand also about ten feet deep, and still lower there is another stratum some eight or ten feet deep composed of hard compact sand compressed and cemented almost to stone. Here the human remains are found lying near the bottom of this lowest stratum and resting nearly on the marls common to this section and generally underlying all the country. The stage in which these remains lie marks a completed deposit of sediment; above them is another local stage, and overlying this is the superficial alluvium, indicating that these remains are historically of great antiquity.

The remains are washed out by the erosion of the river and at times a number of them can be seen. They are entirely different from anything I have ever met. It is evidently an old burying ground. The human remains are packed in clay cylinders rounded at the base and with a spreading cover for the top carefully fitted on and surmounted by a head possibly intended as an effigy of the deceased. In the cylinders the bones are nicely packed and to have crowded them into the narrow space must have necessitated their having been macerated or stripped of the flesh. On top of the cylinder the skull was placed with the cover carefully fitted over to protect it and to close the orifice. Many of these clay burial urns are still in good condition and are found in groups, each having what was perhaps a distinctive headdress.

With some it was a crown, with others plaited bands, and with still others what might be taken to represent plumes. This appears to indicate that each family had its group of urns with special distinguishing marks, but what this may mean or whether my seeing them so placed was simply accident or coincidence, would require careful investigation.

It might reasonably be expected that bones placed in a tight clay cylinder and surrounded by compact sand would endure for a long period, but these are crumbling to pieces and are sometimes nothing but fragments mingled with dust. This fact, together with their position below the usual water line and with three sediments each marking a complete stage overlying them, argues a very great antiquity. It is a curious fact that less than half a mile from them and thence extending some distance back in the country there is a rising ground filled with beds of oyster shells that appear like a species of *Titon*, resembling one of the extinct Miocene types.

These beds of fossils lie very near the human remains and topographically are above them, but to assume that they are stratigraphically so, would be a daring assertion. It is more probable that the human remains represent a subsidence at that point, and that the three overlying strata indicate changing conditions of sediment in filling the collapsed surfaces; and, as many such sediments are found along the river courses, it seems only reasonable to suppose that all these are of recent times geologically considered.

The subsidence of considerable stretches of country in this part of the world has been forcibly illustrated in our times. During the great earthquake of 1893 I was in Rio Hacha. Contrary to common belief in regard to such occurrences the day had been bright and pleasant. It was about nine o'clock in the evening and I had just determined to stop work, when a strange noise and sudden apprehensiveness filled the air. I hurried to the back of the house to see what it could mean, and then, noting that a large building near by was swaying, and hearing the church bells tolling with a deep unearthly sound and hesitating irregularly, I knew what was happening and hurried to the street. While crossing the rooms I could hardly stand, and, just as I reached the door, a final shudder seemed to run through all the earth, then an instant of bewildering silence, and life went on again.

Rio Hacha had had a lucky escape. For days afterward reports came telling of the destruction of life and property over hundred of miles of country. Later, a party of Indians coming in to trade, informed us that the little town of Laguna over toward the Ven-

| | | | |
|---|---|---|---|
| Anatomy | 2 | Microscopy | 1 |
| Anthropology | 5 | Mineralogy | 8 |
| Astronomy | 9 | Paleontology | 8 |
| Botany | 2 | Philology | 7 |
| Civil Engineering | 1 | Physics | 15 |
| Entomology | 1 | Physiography | 2 |
| Geology | 17 | Psychology | 3 |
| Mechanics | 1 | Zoölogy | 17 |

Forty-nine resident members have been elected, six have resigned, and, so far as known, three have died. The net total on the Secretary's list is two hundred and ninety-one, a gain of forty-five over last year. One fellow, one corresponding and four honorary members have been elected.

The new section of Anthropology, Psychology and Philology, organized a year ago, immediately resolved itself into subsections; one of Anthropology and Psychology, the other of Philology. Their meetings have been well attended and much interest has been shown.

The public reception last spring was a very gratifying success and was thoroughly enjoyed by all present. The reception has become an annual feature, and this year will, it is understood, be open one afternoon and two evenings.

Of the Transactions Vol. XV has been delayed by the preparation of a complete index of the first fifteen volumes. Everything has been in the printer's hands for a month now and the volume should be issued at once. It is larger than that of last year, containing 356 pp. and xviii plates. It will have a list of members of all grades, corrected down to December 1, 1896.

Of Vol. XVI., four signatures have been issued with six plates, two more are in press and MSS. is in hand for six more.

Of the Annals Vol. IX. has been completed and Vol. X. begun.

The Academy joined with the other scientific societies of the city in November, and extended a reception to Professor Henri Moissan which was very successful and was finely illustrated.

Respectfully submitted,

J. F. KEMP,
*Secretary.*

The Treasurer's Report was next read.

REPORT OF THE TREASURER OF THE NEW YORK ACADEMY OF SCIENCES FOR THE YEAR ENDING FEBRUARY 22d, 1897.

RECEIPTS.

| | | |
|---|---|---|
| Balance cash on hand as per last annual report,..... | | $3,306.62 |
| Balance of Publication Fund,..... | | 1,823.69 |
| Balance of Audubon Fund,..... | | 1,797.25 |
| Proceeds of $4,100 United States Fours,..... | | 4,442.00 |
| | | $11,369.56 |
| Accrued interest on $3,800 United States Fours,.... | | 38.00 |
| Interest on Bond and Mortgage, account Permanent Fund, ..... | $305.40 | |
| Interest on Bond and Mortgage, account Publication Fund,..... | 72.50 | |
| Interest on Bond and Mortgage, account Audubon Fund, ..... | 23.00 | 400.90 |
| Patron's Fee,.. ..... | 250.00 | |
| Life Membership Fees, ..... | 500.00 | |
| Fellowship Fee,..... | 10.00 | |
| Initiation Fees, ..... | 250.00 | 1,010.00 |
| Annual Dues, 1894,..... | 30.00 | |
| " " 1895,..... | 70.00 | |
| " " 1896,..... | 2,005.00 | |
| " " 1897,..... | 40.00 | 2,145.00 |
| Collected for Huxley Memorial Fund, (Collected in 1895, $105)..... | | 138.00 |
| | | $15,101.46 |

DISBURSEMENTS.

| | | |
|---|---|---|
| Invested in Bond and Mortgage at 5 per cent., on house and lot No. 326 W. 113th st: | | |
| For account Publication Fund, ..... | $1,800 | |
| For account Permanent Fund,..... | 7,200 | $9,000.00 |

at the same time they are equally luminous. The shadows disappear when the difference of illumination between that portion of the screen occupied by them and the adjacent portion is inappreciable and the method evidently depends upon the ability of the eye to detect slight differences in luminosity.

The Bunsen photometer is the type of a large number of photometers depending upon the disappearance of a spot on the illuminated surface when equality of illumination is obtained. The Bunsen screen originally consisted of a disk of white paper having a central translucent grease spot. As originally used, a compensating light was placed at a certain distance behind the screen. One of the two lights to be compared was placed in front of the screen at such a distance as to cause the central spot to vanish. The distance from the light to the screen having been measured, this light was replaced by the light to be compared with it and the distance adjusted until the spot again vanished. The relative intensities of the two lights can then be calculated from the law of inverse squares. The condition for the disappearance of the spot is, evidently, that that portion of the disk shall be of the same luminosity as the adjacent portions and the accuracy of the measurements depends upon the accuracy with which the eye can detect slight differences in luminosity. That it is a comparison of luminosities is made very evident if the light on one side of the screen is of a different color from the light on the opposite side. Under this condition the spot can not be made to disappear.

The polarization photometers of Arago,* Babinet,† and Wild ‡ still further disguise the principle of equal luminosities. The following is a brief outline of the method employed in this class of photometers.

The light from one of the sources is polarized in a given plane and the light from the other source in a plane perpendicular to this. The two rays after polarization travel in the same direction, and by viewing the combined ray with suitable apparatus, certain phenomena are observed which disappear when the quantities of light polarized in planes perpendicular to each other are equal. With photometers of this class, as with the other classes mentioned, the investigator seeks ultimately to obtain a uniform field, and it is, therefore, evident that the accuracy depends, as in the other photometers considered, upon the accuracy with which the eye can detect slight differences in luminosity. The polarization photometers are open to the same objection as the

* Comptes Rendus, XIII., pages 840, 967. 1841.
† Comptes Rendus, XXXVII., page 774. 1853.
‡ Pogg. Ann., XCIX.

others when the two sources of light differ in color. Under this condition it is impossible to obtain a uniform field.

The accuracy of the photometric methods, so far considered, is dependent upon the sensitiveness of the eye to slight inequalities of illumination. Various experiments * for the purpose of determining the degree of sensitiveness show that for white light the eye can detect differences in luminosity of from 3 per cent. to about 0 6 per cent. of the total luminosity of the field, the sensitiveness being less for high and low illuminations than for a field of medium luminosity. If, however, the surfaces compared are of different colors, a judgment concerning the equality of their luminosities is subject to a very much greater error. Indeed Helmholtz † remarks:

"I must explain that personally I put no confidence in my judgment concerning the equality in luminosity of differently colored surfaces. I admit, however, that of two differently colored fields one can be so much darkened that there remains no doubt that the other is brighter.

"For myself I have the impression that in the comparison of the luminosities of differently colored fields I am not dealing with a single magnitude but with the effect of two, luminosity and color, for which I do not know how to form a simple sum, and which I cannot scientifically define."

There have, nevertheless, been many attempts made to compare directly the luminosities of differently colored surfaces. These attempts have, in general, led to slight modifications in the use or construction of the photometers belonging to the types already described.

The difficulty of judging when two differently colored surfaces are of the same luminosity, a difficulty encountered in the use of photometers belonging to any of the classes above described, is, to some extent, obviated by taking the mean of two measurements. A measurement is taken when one of the surfaces is evidently more luminous than the other, another measurement when it is less luminous by the same amount. The average of the two measurements gives a determination of the luminosity. This method was employed by Professor O. N. Rood in measuring the luminosities of colored discs.‡

Another method very commonly used is to continually vary the luminosity of one of the surfaces so that it will be alternately darker and lighter than the other, the amounts of the variation being gradually diminished. By this means the observer can

* Grundzüge der Physiologishen Optik von Hermann Aubert. Page 488. 1876.
† Handbuch der Physiologishen Optik. Second edition, page 440.
‡ American Journal of Science, 1878.

The Upper Coal Measures contain a few coal seams in their lower half, the upper consisting of red shales and thin limestones.

### The Lower Coal Measures.

These Measures bound the northern side of the South Lanshire coal field, and send three arms northwards through the Millstone Grit country to the Burnley coal field, which they completely encircle. Immediately to the south of the latter coal field they cover a tract of country fifteen miles long from east to west and three to five miles broad from north to south.

The Lower Coal Measures include all the beds lying between the Upper Rough Rock of the Millstone Grit Series and the floor of the Arley Mine (also known as "Little Delf" at St. Helens, "Riley Mine" at Bolton, and "Dogstone Mine" at Bury). They consist mainly of shales, with thin bands of nodular ironstone, sandstones, and thin coals, reaching in all a thickness of 1,200 feet along the line of the "Rossendale Anticlinal." Not more than six coal seams are present in the series, the total thickness rarely exceeding ten feet.

The accompanying generalized section in the Rossendale area serves to illustrate the position and thickness of the seams.

| | | Ft. | In. | |
|---|---|---|---|---|
| | Strata ? | 431 | 0 | |
| Upper Mountain Mine | Coal | 1 | 6 | |
| | Strata | 36 | 0 | |
| | Coal | | 2 | |
| | Strata | 56 | 0 | |
| Upper Foot Mine | Coal | | 8 | Five Feet |
| | Strata | 30 | 0 | Mine where |
| Gannister Mine | Coal | 2 | 6 | they unite. |
| | Strata | 20 | 0 | |
| Lower Foot Mine | Coal | | 8 | |
| | Strata | 40 | 0 | |
| Bassey or Salts Mine | Coal | 23 | 0 | |
| | Strata | 100 | 0 | |
| | Coal | | 10 | |
| | Rough Rock | | | |

The coal seams are frequently termed "Mountain Mines," owing to their general occurrence in the high ground. But three are of commercial importance, viz.: The "Gannister," "Yard" or "Lower Mountain Mine;" the "Upper Foot" or "Bullion Mine," and the "Upper Mountain Mine." The "Bassey," or "Salts Mine," is a very impure coal and not much used. It is worked to some extent in the Blackburn area. The Upper

Mountain Mine and the Gannister seam have been largely worked by adits and shafts to supply the wants of the numerous cotton manufacturing towns of Lancashire and are still largely used. The chief coal supply from the Lower Coal Measures will, in the future, have to be drawn from a five-feet seam formed by a union of the Gannister and Upper Foot seams, which takes place along an irregular northwest and southeast line, a little to the north of the Rossendale anticlinal. Although up to the point of union the individual thicknesses of the two mines are but two feet six inches, and eight inches respectively, yet at their junction the united seams swell out to a thickness of nearly 8 feet, and the average over a great area is five feet.

The special features of the union of these two seams were dealt with by J. Aitken, F. G. S., in a paper read before the Manchester Geological Society (See TRANS., Vol. V.) and his explanation is probably the correct one; viz.: That a part of the Gannister area was one of subsidence, the submersion going on until a sufficient depth beneath water was obtained to allow of the deposition of sufficient detritus to form the rock mass overlying that mine and separating it from the thin coal above. He goes on to say in his paper, "it would further appear that the surface over which the five feet coal was then in process of formation remained stationary and undisturbed, and that the operations or nature were not in any way interrupted."

This view is supported by the fact that the coal of the Five Feet Mine is considerably thicker than the aggregate of the two mines while separate, the growth of vegetation over the area being evidently continuous during the period in which the submerged portion was being silted up. When the latter had taken place the coal forest grew out over the shallows, giving rise to the thin "Upper Foot" coal, after which the whole area occupied by the Five Feet Mine and the Upper Foot coals was submerged, and a uniform deposit of mud took place.

The coals are all bituminous and caking. Iron pyrites occur as nodules in some of the coals, and also as a thin film upon joint planes, in some cases (the upper seams) so abundantly as to seriously injure the usefulness of the coal. The demand for these coals is entirely local, and their use as fuel is restricted to engine boilers and the open fireplaces of the people. All the seat-earths or fireclays are much used in the manufacture of firebricks, gas retorts, chimney pots and drain pipes.

The associated flagstones and massive bedded sandstones are quarried to a large extent for building purposes. The houses in many of the smaller towns are nearly all built of sandstone, bricks being used chiefly for inner walls.

synonomy and the want of books dealing with this section of the subject. As a result the published list of coal plants is by no means complete.

The great bulk of the Coal Flora consisted of ferns and Lycopodiaceæ, the latter, however, not restricted to the Coal Measures, the casts of large trunks being not unfrequently found in the sandstone of the Millstone Grits.

The shale roofs of the coal seams are the repositories of fossil plants; ferns, *Calamites* and *Lepidodendra* occurring in abundance. All the under clays or seat rocks contain *Stigmaria*, whilst the roof of the Bullion Seam contains the irregularly rounded nodules already mentioned in which, amidst a tangle of broken up vegetable matter are found stems, twigs, and fruit of *Calamites* and *Lepidodendron*, with their minute structure perfectly preserved.

In addition to the shale roofs, plant fossils are found in some of the shales and sandstones.

In some cases ironstone nodules occur in the shales containing well preserved ferns and *Lepidostrobi*, especially in the shales under the Doe Mine of the Middle Coal Measures of Pendleton.

The sandstones often contain casts of trunks and faint impression of leaves and ferns covered by a thin layer of carbon.

Ferns are most abundant so far as regards species in the shales of the Middle Coal Measures, where they are better preserved than those of the lower series. The stems of *Calamites* and *Lepidodendra* are also less crushed.

Plant remains of any description are scarce in the Upper Coal Measures, *Neuropteris* and *Sphenopteris* being the most common.

The following is a fairly complete list of coal plants determinable by their external form so far as it can be now obtained.

It is a modification of the list published by Mr. R. Kidston.*

## Lower Coal Measures.

CALAMARIÆ.

*Calamitina* (*Calamites*) *approximata* Brongt.
*Stylocalamites* (*Calamites*) *Suckowii* Brongt.
" " *undulatus* Sternb.
" " *Cistii*.

FILICACEÆ.

*Sphenopteris Schillingsii* Andræ.
*Mariopteris muricata* Schl.
*Alethopteris lonchitica* Schl.

* Trans. Manchester Geol. Soc., Vol. XXI., 1890-1-2. "Notes on some Fossil Plants from the Lancashire Coal Measures by R. Kidston, p. 401.

LYCOPODIACEÆ.

*Lepidodendron obovatum* Sternb.
" *aculeatum* Sternb.
*Lepidophyllum majus* Brongt.
*Sigillaria elegans* Sternb.
" *tesselata* Brongt.
" *mammilaris* Brongt.
*Stigmaria ficoides* Sternb.
Rootlets.
*Pinnularia capillacea* Lind. & Hutt.

*Paracalamostachys Williamsoniana* Weiss, is recorded from the "Brooksbottom Coal" and erroneously assigned to the Lower Coal Measures by Kidston. The Brooksbottom Series is in the Millstone Grit.

## MIDDLE COAL MEASURES.

CALAMARIÆ.

*Calamitina* (*Calamites*) *varians* Sternb.
*Eucalamites* " *ramosus* Artis.
*Stylocalamites* " *Suckow'i* Brong.
" " " var. *undulata* Sternb.
*Calamocladus equisetiformis* Schl.

FILICACEÆ.

*Sphenopteris furcata* Brongt.
" *trifoliolata* Artis.
" *Footneri* Marrat.
" *multifida* Lind. & Hutt.
*Neuropteris heterophylla* Brongt.
" *obliqua.*
" *osmundæ* Artis.
" *gigantea* Sternb.
*Odontopteris Britannica* Gutbier.
*Mariopteris muricata* Schl.
" " var. *nervosa* Brongt.
*Pecopteris Miltoni* Artis.
*Alethopteris decurrens* Artis.
" *lonchitica* Schl.
" *Serlii* Brongt.
" *valida* Boulay.
*Schizopteris anomala* Brongt.
*Sphyropteris* sp.

SPHENOPHYLLEÆ.

*Sphenophyllum cuneifolium* Sternb.

LYCOPODIACEÆ.

*Lepidodendron ophiurus* Brongt.
" *Haidingeri* Ett.
" *obovatum* Sternb.
" *aculeatum* "
*Lepidostrobus variabilis* Lind. & Hutt.
" *ornatus* " " "
*Halonia regularis* " " "

3 is drawn from a wax impression of one of the most prominent and most deeply bifid specimens; it ranges from this form to a comparatively low process with the bifurcation almost obsolete.

The species is named in honor of Prof. H. S. Williams.

PRODUCTUS CESTRIENSIS Worthen.*

Pl. XIX., figs. 7–9.

1855. *Productus elegans*, Norwood and Pratten, Jour. Acad. Nat. Sci. Phil. (2), Vol. 3, p. 13, Pl. 1, figs. 7a–c. (Name preoccupied.)

1860. *Productus cestriensis*, Worthen, Trans. St. Louis Acad. Sci., Vol. 1, p. 570.

1891. *Productus elegans*, Whitfield, Ann. N. Y. Acad. Sci., Vol. 5, p. 581, Pl. 13, figs. 15–16.

1895. *Productus elegans*, Whitfield, Geol. Surv. Ohio, Vol. 7, p. 669, Pl. 9, figs. 15–16.

Shell of medium size, subelliptical in outline, hinge line straight, very short.

Pedicle valve strongly arcuate, much broader towards the front than along the hinge-line, with almost no auricular depressions at the extremity of the cardinal line. Beak rather large and obtuse. A shallow, ill-defined mesial sinus extends from near the beak to the anterior margin. Surface ornamented with from thirty to fifty, fine, longitudinal, bifurcating plications which often become fasciculated towards the anterior margin, giving that portion of the shell a wrinkled appearance. In the older shells the pedicle valve is often broadly and rather abruptly expanded towards the margin.

Brachial valve flattened throughout the greater part of its surface, but abruptly bending upward near the margin.

Though this species is exceedingly variable in many respects, it possesses some remarkably constant characters. The most noticeable of these is the shortness of the hinge-line as compared with the width of the shell towards the front, with the obsolete or nearly obsolete auriculations at its extremities. The striking quadrangular appearance of the shell when viewed posteriorly is also a noticeable characteristic, though not so pronounced in the Batesville specimens as in those from some other localities. The specimen illustrated in the accompanying figures shows this characteristic much less than do many others, due to the more rapid expansion of the shell towards the front.

*A complete list of references to the species here described is not always given. In a Bibliographic Index of American Carboniferous Invertebrates, now in preparation by the author, a complete list of references with geographic distribution will be given of all American Carboniferous invertebrates.

### RHYNCHONELLA MUTATA Hall. (?)

Pl. XIX., figs. 13–15.

1858. *Rhynchonella mutata*, Hall, Geol. Iowa, Vol. 1, pt. 2, p. 658, Pl. 23, figs. 2a–b.
1882. *Rhynchonella mutata*, Whitfield, Bull. Am. Mus. Nat. Hist., Vol. 1, p. 52, Pl. 6, figs. 43–45.
1883. *Rhynchonella mutata*, Hall, 12th Ann. Rep. Geol. Surv. Ind., p. 332, Pl. 29, figs. 43–45.

Shell small, subcircular in outline.

Pedicle valve flattened toward the beak, ornamented by thirteen angular plications, three of which are contained in the mesial sinus, which is deeply impressed toward the front of the shell.

Brachial valve more ventricose than the pedicle, most rotund on the umbo, ornamented with plications corresponding to those in the pedicle valve.

There is some doubt about the identification of this species, as it is represented by a limited number of specimens, most of which are fragmentary.

### SPIRIFER KEOKUK Hall.

Pl. XIX., figs. 10–12.

1858. *Spirifer Keokuk*, Hall, Geol. Iowa, Vol. 1, pt. 2, p. 642, Pl. 20, figs. 3a–d, 2d.
1858. *Spirifer Keokuk*, var. Hall, Geol. Iowa, Vol. 1, pt, 2, p. 676, Pl. 24, figs. 4a–d.
1891. *Spirifera Rockymontana*? Whitfield, Ann. N. Y. Acad. Sci., Vol. 5, p. 584, Pl. 13, fig. 30.
1895. *Spirifera Rockymontana*? Whitfield, Geol. Surv. Ohio, Vol. 7, p. 471, Pl. 9, fig. 20.
1895. *Spirifer Keokuk*, Hall and Clarke, Pal. N. Y., Vol. 8, pt. 2, Pl. 30, figs. 21–24.

Shell of medium size, variable in outline, from subcircular to transversely subtrigonal. Hinge-line straight, relative length variable, from shorter than the width of the shell below to much extended into more or less mucronate extremities.

Pedicle valve gibbous in the umbonal region, compressed towards the cardinal extremities. Area moderately broad, sharply defined, concave towards the beak, which is moderately incurved. Mesial sinus sharply defined, moderately deep and regularly rounded, including three rounded plications, of which the middle one is the largest; in some cases two additional plications are pres-

more rapidly posteriorly into the posterior margin, which is sharply rounded dorsally.

Surface nearly smooth, but showing some inconspicuous wrinkles of growth.

This specimen is almost certainly not a *Schizodus*, but as it seems difficult to place it in any genus with certainty it is placed here provisionally.

SANGUINOLITES? SP?

Pl. XXI., fig. 6.

Shell elongate sub-ovate in outline, moderately convex along the umbonal ridge. Beaks depressed, situated at a point about one-fourth the distance from the anterior to the posterior extremities of the shell.

Hinge-line straight, about two-thirds the length of the shell. Anterior margin of the shell sinuate just below the beaks, regularly rounded below. Ventral margin straight or slightly arcuate. Posterior margin rather sharply rounded.

Surface smooth except for some indistinct concentric lines of growth.

This species occurs rather abundantly, but the specimens are all so poorly preserved that the characters can be but imperfectly recognized. The specimens are placed provisionally in the genus *Sanguinolites*, but more perfect materialmust be studied for the accurate determination of their characters.

GASTROPODA.

CAPULUS ACUTIROSTRIS Hall.

1856. *Capulus acutirostris*, Hall,Trans. Albany Inst.,Vol. 4, p. 31.
1858. *Capulus acutirostris*, Hall, Geol. Iowa, Vol. 1, pt. 2, p. 665, Pl. 23, figs. 14a–b.
1882. *Platyceras acutirostris*, Whitfield, Bull. Am. Mus. Nat. Hist., Vol. 1, p. 67, Pl. ×, figs. 13–15.
1883. *Platyceras acutirostris*, Hall, 12th Rep. Geol. Surv. Ind., p. 370, Pl. 31, figs 13–15.
1890. *Capulus acutirostris*, Keyes, Proc. Acad. Nat. Sci., Phil., p. 170.
1894. *Orthonychia acutirostre*, Keyes, Mo. Geol. Surv., Vol. 5, p. 190, Pl. 54, figs. 2a–c.

A single specimen in the collection agrees well with the figures and descriptions of *Capulus acutirostris*. It is imperfectly preserved, but seems referable to this species.

### BELLEROPHON SUBLAEVIS Hall.

Pl. XXI., fig. 10.

1856. *Bellerophon sublaevis*, Hall, Trans. Albany Inst., Vol. 4, p. 32.
1858. *Bellerophon sublaevis*, Hall, Geol. Iowa, Vol. 1, pt. 2, p. 666, Pl. 23, fig. 5.
1882. *Bellerophon sublaevis*, Whitfield, Bull. Am. Mus. Nat. Hist., Vol. 1, p. 89, Pl. 8, figs. 6–7.
1882. *Bellerophon sublaevis*, White, 11th Rep. Geol. Surv. Ind., p. 359, Pl. 40, figs. 5–7.
1883. *Bellerophon sublaevis*, Hall, 12th Rep. Geol. Surv. Ind., p. 371, Pl. 31, figs. 6–7.
1891. *Bellerophon sublaevis*, Whitfield, Ann. N. Y. Acad. Sci., Vol. 5, p. 592, Pl. 14, figs. 20–21.
1894. *Bellerophon sublaevis*, Keyes, Mo. Geol. Surv. Vol. 5, p. 148.

The Arkansas specimens of this shell are all imperfectly preserved and in the form of internal casts. There seems to be no doubt, however, as to the accuracy of their identification. But little can be said in the way of description of the specimens, except that they are sub-globular in form with a smooth surface.

All the specimens of this species in the Walker Museum collection are so much crushed and distorted as to be unfit for illustration. The figure on plate 3 is from a specimen in the U. S. G. S. collection loaned for illustration by Professor Williams.

### BELLEROPHON BRANNERI sp. nov.

Pl. XXI., fig. 9.

Inner volutions of the shell small, closely coiled. Outer volution broadly expanding toward the aperture, subangulate along the dorsum. Aperture large, sub-circular in outline, with a slightly sinuate dorsal margin. Shell ornamented with rather remote transverse undulations.

This species is represented in the collection by a single imperfect example, but it is so distinct from every other Carboniferous species that it is given a specific designation. The figure is drawn from a wax cast of the mould of the specimen in the sandstone. It is similar to the Devonian species *B. natator*, Hall,* but differs from it in having a shallower and less sharply sinuate dorsal margin in the aperture, and in having a less angular dorsum. The transverse undulations are also more remote in the Arkansas species.

* Pal. N. Y., Vol. 5, pt. 2, p. 108, Pl. 24, fig. 1.

they may be distinguished by being more narrow, less curved and having the summit prolonged into a relatively slender and acute point. In *S. tumidus* the spine is broader and more curved and the dorsal prominence is more elevated and were perfectly bilobed. From the smaller spines of *Stethacanthus* found in the same beds and described in this paper (*S. compressus*) these may be distinguished by their much greater size, lesser curvature, greater relative thickness and different form of the dorsal prominence.

In the same beds with the spines of *Stethacanthus productus* are found certain anomalous fin-spines, which are at first sight very different from *Stethacanthus*, and yet while different in form they are composed of the same peculiar osseous material and have the same smooth, unornamented surface, show the same want of symmetry and have a similar cleft or sulcus along the back. They are about four inches long by one inch or more in width, robust, straight, triangular in outline with the base sloping backward. The cleft along the posterior margin is similar to that of several species of *Stethacanthus* and reaches quite to the summit, which is obtuse. The margins which border the posterior fissure are of unequal width, making the spines unsymmetrical and showing that they were not set on the median line. As I have shown, all the spines of *Stethacanthus* hitherto described were attached to the pectoral fins, the bases of which were inserted in its posterior clefts. In like manner, as it seems to me, the short, straight spines I have described were connected with the other paired fins, the ventrals. It is scarcely probable that we shall ever find in the Burlington limestone the complete fins of *Stethacanthus*, as we have done in the Waverley shales of Ohio, and so will always want the demonstration which the Ohio specimens furnished, and yet the structure of these short, straight spines is so entirely what it would have been if the ventral fins of *Stethacanthus* had been provided with spines, that I think we may fairly infer that such was their character.

Formation and locality, Burlington limestone, Burlington, Iowa. Type in the cabinet of Mr. W. F. E. Gurley, of Danville, Illinois.

STETHACANTHUS COMPRESSUS, n. sp.

Pl. XXIII., figs. 3–4.

Pectoral spines of small size, three to five inches long, one inch wide at base, very much compressed, extremity long, pointed, dorsal prominence relatively large, rising at a high angle, oval, flattened, with acute edges. Beneath this prominence the spine is compressed to an acute edge.

These small spines are somewhat different in form from any of the group to which they belong, being relatively broader toward the base and more slender and acute at the summit, while the body is much compressed. The dorsal prominence is peculiar in its breadth and acute edges. These spines are all quite unsymmetrical, the thin margin which borders the posterior sulcus being much broader on one side than on the other. In size and general form they are not unlike those figured by St. John and Worthen in Vol. VI. of the Geological Survey of Illinois, Pl. 18, figs. 7, 8 a and which are erroneously referred to *Physonemus gigas*, N. & W. The spines before us are, however, more compressed than those referred to, are broader at the base and the dorsal prominence is more flattened. By comparing the figures now given with those contained in the volume cited, it will be seen that the differences from any form there described are such as to require them to be regarded as forming a distinct species.

In my notes on *Stethacanthus* contained in Monograph XVI. of the U. S. Geol. Survey, I have shown that all the spines similar to *Physonemus altonensis*, St. J. & W., are generically distinct from *Physonemus*, that the surface was never ornamented with tubercles and that they were certainly spines of the pectoral fins. Both the latter points are proven by the discovery of two spines in the fine argillaceous shale with the fins still attached and the surfaces perfectly smooth.

Formation and locality, Burlington limestone, Burlington, Iowa. Type specimen in the cabinet of Mr. W. F. E. Gurley, Danville, Ill.

### Asteroptychius gracilis, Newb.

(No figure of this species has been found.—*Ed.*)

Spines of small size, straight and extremely slender, about four inches long by one-fifth inch in breadth at base; buried portion relatively long (one inch in the type specimen) conical in form, regularly and finely striated throughout; ornamented portion nearly circular in section, traversed by a few strong, polished ridges, 4 or 5 at base, 2 near summit, separated by striated, depressed bands. On the anterior margin near the base are set several conical tubercles. The posterior face carries two rows of relatively large, conical, subacute denticles which are turned upward, unless at the tip, which is wanting in the type specimen.

This slender and distinctly marked spine is most like *Asteroptychius St. Ludovici*, St. J. & W., described in Vol. VI. of the Report of the Geological Survey of Illinois, p. 437, Pl. 16, figs. 3 a to 4 g, but it is less curved, more slender, less compressed, has

transversely, gently arched longitudinally, ends rounded; surface without folds, uniformly and finely punctate.

The generic relations of these teeth are somewhat obscure, but they approach most nearly those described in the 4th volume of the Geological Report of Illinois, p. 369, Pl IV., fig. 3, with the name *Sandalodus crassus;* the teeth of that species are, however, longer, narrower at the anterior extremity and less symmetrically arched behind. Among a large number of teeth of *Sandalodus crassus* recently received from Mr. William McAdams, Alton, Ill., are some which are quite complete, and these show a prominent point extended from the straight side beyond the crown surface, a feature which does not appear in the figure cited. Probably such a point or angle projected from the posterior end of the teeth before us, so that the general outline was less elliptical than that of the crown surface.

Mr. Orestes St. John has transferred *Sandalodus crassus* to his genus *Orthopleurodus*, perhaps with reason, though it is separated somewhat widely from *O. carbonarius* of the Coal Measures. The teeth under consideration could not follow *Sandalodus crassus* into *Orthopleurodus*, as the anterior extremity is broader and rounder and neither side is straight.

With the nearly complete tooth now figured is a fragment of another which was apparently about the same size and shape and is evidently the corresponding tooth from the other side of the mouth. Taken by itself this fragment might readily be mistaken for the posterior extremity of a tooth of average size of *Sandalodus crassus*, but the anterior portion is wanting. If the more complete tooth has suffered no injury, its rounded extremity separates it widely from all species of *Sandalodus* and brings it nearer in form to the tooth which I obtained from the Keokuk group in central Kentucky and described in Vol. II. of the Paleontology of Ohio, p. 38, and named *Platyodus lineatus.* Since then Mr. St. John has described, in Vol. VII. of the Report of the Geological Survey of Illinois, p. 82, a large though imperfect tooth from the Kinderhook group, which may have had somewhat the form of those now under consideration, and is, perhaps, referable to the same genus. This tooth he has called *Vaticinodus vetustus.* Unfortunately all the anterior portion of the tooth is lacking, and therefore satisfactory comparisons cannot be made. All these teeth have a general resemblance in their oblong or elliptical outline and low arched crown to the tooth of *Platyodus* referred to above, and yet the linear punctation of that tooth indicates differences that are probably generic.

With more material it may be necessary to give the teeth now described a new generic name, but without such material it would

hardly be possible to give the full and accurate generic definitions which are desirable to avoid adding to the great mass of synonymy in Paleontology.

Formation and locality, Kinderhook group, Le Grand, Iowa. Type in the cabinet of Mr. William F. E. Gurley.

PSEPHODUS (HELODUS) POLITUS, n. sp.

Pl. XXIV., figs. 13–23.

Teeth of various forms and sizes, generally oblong with rounded ends, more or less arched in both directions; root low, parallel with the crown, smooth and often polished below, one side sloping to the edge of the crown, on the other higher, vertical, strongly striated; crown highly polished, uniformly punctate, sometimes low and broadly arched in both directions, in other and narrower teeth strongly arched and rising into a rounded boss; one lateral margin of the crown projecting beyond the root and terminating in an obtuse edge, on the other side coarsely crenulated.

The smaller, narrower and more highly arched of these teeth would be accepted as typical specimens of *Helodus* which are undoubtedly the anterior teeth of various Cochliodont fishes, a good example being *Helodus nobilis*, the central teeth of *Cochliodus nobilis*, N. & W. described in Vol. II., of the Geological Survey of Illinois, p. 88, Pl. VI., both forms occurring in juxtaposition.

With these smaller teeth occur others larger, less strongly arched and in form approaching nearer to those of *Psephodus* and evidently to be classed generically with *Helodus placenta*, N. & W., from the Kinderhook group a form which Mr. St. John makes the type of his *Psephodus placenta*. But the teeth which are now figured and which are alike in the peculiar character of their *highly polished* and punctate enamel include none that have much affinity with the teeth of *Psephodus magnus*, Ag. or those of its generic associate *Psephodus crenulatus*, N. & W., from the Chester limestone of Illinois. I am, therefore, very doubtful whether they should be included in the same genus, and yet more material will be necessary before this question can be definitely settled.

Formation and locality, Burlington limestone, Burlington, Ill. Type in the cabinet of Mr. William F. E. Gurley.

HELODUS COXANUS, n. sp.

Pl. XXIV., fig. 24.

Median teeth, five or more in a linear series, increasing in size

pocket, less than a foot in diameter, lying between a number of large rounded stones. The water, 66° F. in temperature, was sweeping across it in a moderately strong current. The temperature of the air at the time was 70° F. The water-depth in the nest was about ten inches.

The lampreys were in constant movement, sometimes crowding closely together, ten or twelve in number, now and again scattering, many leaving the nest and others returning. Occasionally the nest would be almost deserted. The greatest number was observed about noon-time. The entire party seemed to devote its attention to transporting gravel: the spawning process occurred at irregular intervals and was of very short duration. At first it proved difficult to distinguish males and females. They are almost equal in size and thickness, and the slight differences in fin-characters could not well be seen when the animal was in motion. So too, the erected urinogenital papilla of the male was only occasionally distinguishable. It was later evident, however, that the males were by far the more numerous. Examination of the lampreys taken from this neighborhood, but not from the nest alone, showed that the proportion of males to females was about 5 to 1. It is a reasonable inference, therefore, that this species is polyandrous although this could not be verified in the present instance, the active movements of the animals preventing the observer from following the male till its return to the same female. The mode of mating could, however, be clearly followed. The female, after many circlings about the nest, attaches to a stone and is apparently struggling to move it. Then a male, which up to this point has been diligently stone-moving and is now close by, suddenly seizes his mate "somewhere near the head, he then winds himself half way round the female whereupon the two bend their tails downward and stir up the sand by the most vigorous movements" (Gage).

The actual position of a pair during copulation is shown in the plate. The male attaches the oral disc to the back of the head of a female, somewhat in front of the eye and slightly on the right side. The back of the male is then instantly arched and the tail region wound around the hinder trunk of the female, forming one turn of a left handed spiral. Its increasing curve toward the tail causes the body of the male to here lie at right angles to that of the female. This position was verified in eleven instances. In only one case the body of the male appeared to be wound in the reverse direction. During this process, the body of the male is so rotated that the urino, genital papilla becomes apposed to the cloaca of the female-this result being aided by an upward arching of the latter's body.

The extrusion of eggs and milt which instantly follows is accompanied by rapid vibration of the hinder body region of both male and female, the tails directed brush-like against the sand. The number of vibrations was estimated to be about ten or twelve in the brief time of pairing, about three seconds. Few eggs relatively could, therefore, be extruded at a time. At this moment they may be seen in the water, but they speedily sink with the flurry of sand. The total number of eggs found in one well-distended female was calculated to be 860.

The milt is nearly colorless, causing no cloud in the water at the time of emission. The great length of the slender papilla (4 mm.) suggests that an actual intromission occurs, but of this there appears to be no evidence. The short duration of mating and the immediate outcasting of the eggs are, it is evident, decidedly opposed to this method of fertilization. But to determine by direct observation that no intromission occurs is exceedingly difficult; the pairing takes place unexpectedly and terminates suddenly and during the few intervening seconds the observer is confused by the rapidity of the movement. In a single favorable instance, at the close of the vibration, the papilla was seen to be separate from the cloacal opening of the female. Probably, therefore, the papilla serves to direct the milt upon the discharging eggs rather than as an intromittent organ. In the present nest ovulation took place at irregular intervals, in one case after a lapse of two minutes, but usually after a longer time. In one instance a male attached for a moment to another male, and frequently one would be seen to suddenly seize and pull another away from where it happened to be. Copulation was later observed among lampreys which had been placed in an aquarium. It was here also noticed that the papillæ of the males sometimes remained protruded for many minutes; and in separate individuals, probably of both sexes, the vibratory movement of the tail was frequently observed when no copulation occurred.

Gage notes that lampreys of this species "are somewhat communistic or gregarious and join in considerable numbers, sometimes eight to ten, to make a common nest." A few details as to the utilization of the common nest were observed in the present instance. The females did not return to exactly the same spot in the nest when ovulating; they seemed in fact to deposit eggs during intermission of stone-carrying, wherever they then happened to be—usually, however, near the margin of the nest. The eggs then often became attached to the sides of the large stones in the neighborhood. No definite mass of rock fragments was accumulated, for although the same lamprey would for a

terminates in a flat, tendinous lamella, which joins the tendon of insertion of the Ento-pectoral along the caudal margin (Pl. XXX., fig. 2).

The tendon of the Entopectoral passes underneath that of the Supraspinatus (Pl. XXX., fig. 2; Pl. XXXI., fig. 1) and expands into the cephalic and lateral portions of the humeroscapular capsule, reaching the lateral humeral tuberosity and covering the intra-capsular portion of the long tendon of the Biceps.

*Main Tendon of Insertion of Ectopectoral.*

After separating the abdomidal slip from the remainder of the Ectopectoral—which can be accomplished without dividing muscular fibres—the main tendon of insertion is seen folded on itself (Pl. XXXI., fig. 2) so as to form two lamellæ of unequal width, united caudad, open cephalad. The superficial lamella derived from the cephalic and middle sternal origin of the muscle, extends from the lateral humeral tuberosity to the distal extremity of the lateral bicipital crest, overlapping cephalad the combined insertion of the Entopectoral and abdominal portion of Ectopectoral.

The caudal sternal fibres of the muscle, passing successively underneath the caudal margin of the preceding, form the deeper lamella, only one-half as wide as the superficial, the direction of the tendon fibres intersecting obliquely.

The analysis of the entire pectoral insertion, therefore, results in establishing the following five divisions or layers, proceeding from the deep to the superficial parts:

1. Axillary arch tendon from Latissimus dorsi (Pl. XXIX.).
2. Tendon of Entopectoral and abdominal portion of Ectopectoral, constituting a separate layer (Pl. XXX., fig. 2).
3. Fibres from the caudal sternal origin of the Ectopectoral develop the deep lamella of the main Pectoral tendon (Pl. XXXI., fig. 2).

Continuous with this along the caudal border is

4. The superficial lamella of the Ectopectoral insertion, derived from the muscular fibres which arise from the cephalic and middle sternal attachment (Pl. XXXI., fig. 2).
5. On the superficial aspect of this tendon the clavicular portion of the Ectopectoral finds its insertion, closely fused with the adjacent margin of the Deltoid (Pl. XXXII., fig. 1).

The published descriptions of the anatomy of the Pectoral group in the Lemuroidea do not agree in some main points with the conditions found in our species.

Murie and Mivart (**1**, p. 25), describing the Ectopectoral of *Lemur catta*, distinguish the three portions of the muscle, in respect to their origin, as clavicular, sternal and abdominal.

The insertion of the clavicular portion is described as into the ulnar side of the Deltoid ridge, not connected with the remainder of the muscle, but "dipping somewhat underneath the Deltoid." The sternal portion is said to have "a broad tendinous insertion into the margin of the bicipital groove, in close juxtaposition to the insertion of the first portion." No mention is made of any doubling of the tendon of insertion of the sternal portion, which undoubtedly did not exist in the species examined. The authors find that in *L. catta* the abdominal portion of the muscle has "an aponeurotic insertion beneath and in close union with the insertion of the second (sternal) portion," the union of this division with the tendon of the Entopectoral apparently not having occurred in the species described.

The same authors (**1**, p. 26) find the general arrangement of the Ectopectoral in *Lemur varius* very nearly the same as in *L. catta*, differing, however, in having no clavicular portion.

Cuvier (**11**, Pl. LXVIII.) delineates the Pectoral muscles of *L. varius*, indicating a distinct clavicular portion and representing the union, at the insertion, of a cutaneous muscular slip with the second or sternal portion of the muscle (cf. infra, axillary arch).

According to Murie and Mivart (**1**, p. 26, Pl. II., III., IV figs. 3, 5, 13 and 14, *P. ma.*) the Ectopectoral in *Galago crassicaudatus* and *G. allenii* does not present the separation of the origin into the three portions, the clavicular and posterior (caudal) origins being reduced.

They find, however, that the general arrangement of the insertion in *Galago* agrees with that described for *L. catta*.

Kingma (**7**, p. 21) describes the Ectopectoral of *Galago peli* as consisting of two layers, one being derived from the clavicle, the other from the sterno-costal articulation, both inserted into the great tuberosity of the humerus.

Cuvier (**11**, Pl. LXVII., fig. 2, *j* and *j'*) shows the third or abdominal part of the muscle in *Loris gracilis* as being relatively larger than in *Lemur catta*, and as extending up beneath the superficial portion to a higher point. The Ectopectoral does not appear to have a clavicular origin in this form. *Nycticebus* also lacks the clavicular portion.

Van Campen (**3**, p. 27, Pl. II., fig. 10, 1.) describes the Ectopectoral in *Perodicticus* (Potto) as composed of two bundles, and Burmeister (**6**, p. 50, tab. 4, figs. 2, 17 and 15) says that in *Tarsius* the muscle presents only two portions; one, the smaller, arising from the clavicle and sternum; the other larger portion from the sternum and cartilages of the ribs to the ninth. The insertions of the two portions are said to be much as in the Lemurs.

Owen (**8**, p. 60, Pl. XXII. and XXIII., figs. 1, 17) describes only two portions in *Cheiromys;* the same arrangement was found in this animal by Murie and Mivart, but in this specimen the clavicular portion arose by a tendon from the sternal end of the clavicle.

Lucæ (**12**, p. 27) in his monograph on *Lemur macaco* gives a brief description and a delineation of the Pectoral group. He states nothing regarding a separation of Ento- and Ectopectoral. He describes the Pectoralis (Ectopectoral? P. major?) as having two divisions; the anterior (cephalic) smaller division arises from the sternal end of the clavicle, cartilage of first rib and manubrium of sternum, and descends, connected with the Deltoid, over the upper third of the humerus. The posterior (caudal) larger division is described as arising from the entire length of the sternum and the cartilages of the anterior (cephalic) ribs, and as being inserted underneath the preceding portion, into the head of the humerus and the *Coracoid process* (!) This is the only instance mentioned in the descriptions of the various genera in which the Pectoral fibres are said to have obtained an attachment to the coracoid process. Further reports on the arrangement of the Pectoral group in *L. macaco* are desirable, as Lucæ's account is neither full nor explicit.

Allen (**13**, p. 42) describes the Ectopectoral of *Tarsius fuscus* as "small and composed of two fascicles. The sheet is not folded. The superficial fascicle consists of an upper and lower congeries of fibres, which are distinguished by their trend rather than by relation. The fibres of insertion are continuous inferiorly with the *Deltoideus*." He does not mention the Entopectoral.

The Entopectoral of *Lemur catta* is described by Murie and Mivart (**1**, p. 27) as a strong, thick muscle arising from the sternum beneath the Ectopectoral, the origin extending from the second to the sixth rib inclusive. The insertion is into the capsular ligament of the humerus.

The extent of the origin (second to sixth rib inclusive) agrees with the arrangement of the muscle in *L. bruneus*, but in the latter species the main points of origin are from the costal cartilages, only a few fibres arising from the lateral margin of the sternum in the corresponding intercostal spaces.

Cuvier (**11**, Pl. LXVIII., fig. 1, $j^2$) figures the muscle in *L. varius*. Murie and Mivart (**1**, p. 27) find it of large size in *Galago crassicaudatus*, and state that the arrangement of the muscle is the same as in *L. catta*. They failed to detect any trace of an Entopectoral muscle in *Galago allenii*.

Van der Kolk and Vrolick (**4**, p. 44) state that the muscle is present in *Loris*, its fibres intermingling with those of the Ectopectoral. In this species the muscle is said to be inserted into "the internal (?) tubercle of the humerus, previously passing before the coracoid process."

Cuvier (**11**, Pl. LXVII., fig. 2, $j^2$) represents it as very small in *Loris gracilis*.

Murie and Mivart (**1**, p. 27) find it distinct in *Nycticebus tardigradus*.

Van Campen (**3**, p. 27, Pl. II., fig. 10, 2) describes the muscle as broad in *Perodicticus*, inserted into the greater tuberosity of the humerus.

Burmeister (**6**, p. 51, tab. 4, figs. 2, 18) describes the muscle as well developed in *Tarsius*, "arising from the second to the seventh rib, inserted into the sharp outer edge of the bicipital groove and ridge," close to the Ectopectoral.

Owen (**8**, p. 60) describes the muscle in *Cheiromys* as arising from the side of the presternum, and from the sternal ends of the first to the fifth ribs. The insertion is by a strong tendon which spreads over the head of the humerus, to be attached to the great tuberosity.

Murie and Mivart ( , p. 27) in their specimen of *Cheiromys* found the muscle arising from the cartilages of the 4th, 5th, 6th and 7th ribs.

In comparing the observations cited with the results of the dissection of the Pectoral muscles in *Lemur bruneus* the following considerations suggest themselves:

1. The connection of the Pectoral insertion with the tendon of an axillary arch from Latissimus dorsi has not before been observed in any of the Lemuroidea. The arrangement of the arch in our species is in accord with the conditions presented by the majority of the lower monkeys, especially the Cynomorpha. The only point of difference to be noted is the complete union of the tendon of the arch with the Pectoral tendon. In the Cynomorpha the tendon usually expands more into the deep brachial fascia over the Coraco-brachialis and short head of the Biceps. This corresponds to the condition usually found in man, although the arrangement presented by the little muscular slip in *Lemur bruneus*, *i. e.*, union with the deep surface of the Pectoralis tendon, constitutes a distinct variety of the human axillary arch.

The muscular slips described and figured by Murie and Mivart (**1**, Pl III., fig. 5, Pc.) in the *Grand Galago*, and by Lucæ (**12**, p. 26, tab. 2, 22) in *Lemur macaco*, as humeral portions of the paniculus carnosus are undoubtedly homologous with the axillary slip from the Latissimus dorsi which our species presented.

muscle as double in *Perodicticus*, Owen (**8**, p. 60) in *Cheiromys* and Burmeister (**6**, p. 49) in *Tarsius spectrum*

Allen (**13**, p. 43) merely states that in *Tarsius fuscus* the association of Biceps and Coracobrachialis conforms to the primate type.

C. M. Brachialis (anticus).

(Pl. XXXII., fig. 2; Pl. XXXIII.)

Arises from the whole lateral surface of the humerus, passing as a very strong tendon cephalad as far as the distal border of the lateral humeral tubercle, between the lateral humeral head of the Triceps and the dorsal division of the Deltoid, whose insertion is not embraced by the Brachialis.

Insertion into the Coracoid process.

D. M. Dorso-Epitrochlearis.

(Pl. XXX.; Pl. XXXI., fig. 1; Pl. XXXII., fig. 2; Pl. XXXIII.)

Origin by two slips which embrace the caudal margin of the Latissimus dorsi. Insertion into the mesal border of the Olecranon and proximal fifth of the dorsal border of the shaft of the ulna.

Murie and Mivart (**1**, p. 32) describe the origin of the muscle in *L. catta* as taking place from the "outer margin of the Latissimus dorsi near the insertion (*i. e.*, just before it becomes tendinous)." It broadens out into a thin muscular sheet, and becomes continuous with the fascia of the forearm between its two insertions, which are into the inner condyle of the humerus and the olecranon.

Cuvier (**11**, Pl. LXIX., fig. 1, $t^3$) shows the muscle in *L. varius* arising from the tendinous part of the Latissimus dorsi and passing to the shaft of the ulna.

It is present in the *Galagos* examined by Murie and Mivart ("insertion into inner side of olecranon process"), in *Tarsius* (Burmeister) and in *Cheiromys* (Owen).

E. M. Epitrochleo-anconeus.

*Origin:* 1. From the entire dorsal border of the supracondylar arch, nearly meeting the insertion of the Coracobrachialis inferior, which is attached to the margin of the supracondylar foramen.

2. From the medial condyle of the humerus. The fibres converge to be inserted into the mesal margin of the Olecranon.

The ulnar nerve passes beneath the muscle, between it and the medial humeral head of the Triceps, the fibres of insertion of the

Epitrochleo-anconeus into the olecranon succeeding those of the medial head of the Triceps.

## Summary.

The main facts, heretofore not described, concerning the muscle groups with which the paper deals, are as follows:

1. Presence of an axillary arch from Latissimus dorsi to the Pectoral insertion, replacing the cutaneous muscular slips described by Murie and Mivart in *L. catta* and by Lucæ in *L. macaco*.

2. Arrangement of the Pectoral insertion:

a. Connection as just stated with a slip from Latissimus dorsi, reproducing the condition found as a distinct variety of the human axillary arch.

b. Connection of the abdominal division of the Ectopectoral with the Entopectoral at the insertion into the lateral humeral ridge.

c. Folding of the Sterno-costal sheet of the Ectopectoral at the insertion.

d. Insertion of clavicular portion of Ectopectoral into the superficial aspect of tendon of the sternal division, and fusion with adjacent margin of Deltoid.

e. Lateral recession of caudal portion of Ectopectoral and Entopectoral origin.

3. Coracobrachialis presents a division into upper, middle and lower portions, the latter inserted into the root of the supracondylar arch. The musculo-cutaneous nerve perforates the middle division.

4. Presence of a large and distinct Epitrochleo-anconeus muscle, passing from the supracondylar process and medial condyle to the medial margin of the Olecranon.

5. Union of Brachialis anticus and lateral humeral head of the Triceps, both extending nearly to the proximal end of humerus on the lateral aspect of the shaft.

6. Among the trunk muscles the arrangement of the Supracostal muscle is to be especially noted, extending from the cartilage of the 1st rib to the 3d, 4th and 5th cartilages and the border of the mesosternum.

7. In the abdominal group the structure of the External Oblique aponeurosis clearly foreshadows the condition found in higher Primates, especially in relation to the construction of the External abdominal ring, Gimbernat's ligament and the Triangular or Colles' ligament of Human Anatomy.

The examination of the above detailed muscular groups in *Lemur* leads to certain general considerations in reference to the affinities of the genus.

STATED MEETING.

October 11th, 1897.

The Academy met with President STEVENSON in the chair.

The minutes of the last meeting were read and approved.

The following nominations of new members were made:

*Honorary*—Dr. Fridtjof Nansen, Christiania, Norway.

*Resident*—Dr. G. S. Allan, 51 W. 37th St.; E. C. Brown, 280 Broadway; W. S. Day, 203 W. 85th St.; Francis E. Lloyd, Teachers' College; Emerson McMillin, 40 Wall St.; Andrew Shiland, Jr., 262 W. 78th St.

The Section of Biology then organized, Professor WILSON in the chair; thirty-five persons present.

After reading the minutes, the following programme was presented:

C. L. Bristol, "Preliminary Peport on the New York University Biological Expedition to the Bermudas, 1897."

H. F. Osborn, "A Palæontological Reconaissance."

G. N. Calkins, "Preliminary Report on the Columbia University Zoölogical Expedition to Alaska, 1897."

O. S. Strong, "The Summer at the Marine Biological Laboratory at Wood's Holl, Mass."

Professor Bristol briefly reported on the scope of the work done during the summer at the Bermudas, giving an outline of the plan of operation and the typical forms of life observed.

Professor Osborn described the summer's work of the palæontological expedition from the American Museum of Natural History to Colorado, and especially the finding of a huge dinosaur, in Wyoming, a complete fossil horse, and a llama in the Huerfano fossil beds of Colorado.

Mr. Calkins reported on the results of the Columbia University Zoölogical Expedition to Puget Sound and Alaska, describ-

ing the general biological environment and the nature of the fauna in the Sitka harbor. He also spoke of the wreck of the steamer Mexico, by which the bulk of the summer's work was lost

In the absence of Dr. Strong, Mr. H. E. Crampton reported on the line of work followed at the Marine Biological Laboratory at Wood's Holl during the summer of 1897.

GARY N. CALKINS,
*Secretary.*

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SECTION OF GEOLOGY.

October 18th, 1897.

The Academy met with President STEVENSON in the chair.

There being no business the Section of Geology immediately formed, with twenty-four members present.

The minutes were read and approved.

Professor Stevenson then gave an interesting and careful account of the International Congress of Geologists at Saint Petersburg, and summarized the work done by the Congress in the way of discussion, appointing committees, etc. Additional notes were given by Professor Martin, who spoke particularly of the handbook for the excursions, which summarizes the geology of Russia, and gives access to much material which has hitherto been hard to reach.

The second paper of the evening was by Mr. Charles Bullman and was entitled "The Auriferous Gravels of Colombia, South America." Mr. Bullman spoke particularly of the distribution and richness of the deposits of gold and platinum, which seemed to him, from his examinations, to be much more extensive and valuable than had been reported by Mr. Nicholas in a previous paper before the Section.

In the opinion of Mr. Bullman, the gold deposits are still being accumulated in the river valleys, and are as rich now, with few exceptions, as they were before they were first worked

pulp; and the crown is long and pointed, but still retains much of the spatulate shape. Dr. Matthew concluded that the first differentiation of all the placental mammals took place at the beginning of the Tertiary and not in the Cretaceous, as has frequently been stated. The paper was discussed at length by Professor Osborn and Dr. Wortman.

Mr. Harrington reported on some of the observations which he had made on earth worms during copulation. He described an organ which apparently has been usually overlooked. This organ, the spermatophere of some authors, consists of a modified seta, much enlarged at the extremity and functioning, as Mr. Harrington suggests, to force spermatozoa into the seminal receptacles of the other worm.

GARY N. CALKINS,
*Secretary of Section.*

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SECTION OF GEOLOGY.

November 15th, 1897.

Meeting was called to order by President Stevenson at 8:10 with 84 persons present. There being no Academy business, the Section of Geology was immediately formed, and the reading of the minutes was dispensed with by mutual consent.

The first paper of the evening was by Dr. F. J. H. Merrill, of the State Museum, Albany, on "The Geology of Greater New York." Dr. Merrill devoted his attention to the region east of the Hudson River, and occupied by the crystalline and metamorphic rocks. He stated that the area consisted first of the high mountains of the Highlands, composed of the pre-Cambrian granite; on the valley sides are gneisses, lying on the slopes of the ridges, and in the bottoms of the valleys are limestones and rarely quartzite. These latter rocks are very highly metamorphosed, and probably belong in the Upper Cambrian and Silurian Series. Besides the rocks mentioned, there are also intrusives, cutting the altered paleozoics, including granite and basic rocks.

The granites are sheared into gneisses, and mention should also be made of the eruptives, that have formed serpentines. Besides these rocks, there are three classes which may be called stratified, because folds can be measured within them. At the base may be found a stratified granite, composing the Fordham gneiss; above this a thick limestone deposit, and above this the well-known mica-schists, which compose the most of the island. The Fordham gneiss is undoubtedly pre-Cambrian, and is covered locally as at Lowerre, Hastings, Sparta, Peekskill, etc., with very thin quartzite, probably the representative of the Georgian quartzite of Dutchess county. The crystalline limestones occupy the navigable river-bottoms, and most of the valleys in the vicinity of New York, and thus have had a very important effect on commerce. The mica-schist is probably of Hudson River age, and has a structure trending N. 40 E., with certain cross foldings. Fissures are filled in certain places, by intrusions of granite and pegmatites. The whole series is crossed by a fault, named by Professor Dana the Manhattanville Fault, running from Manhattanville on the North River to the East River, and thence between Ward's and Blackwell's Islands, to Astoria. The throw of this fault is probably a number of hundred feet. The paper was discussed by Professor Kemp, Professor Martin and the secretary

The second paper of the evening was by Captain J. J. Riley, entitled "The Guano Deposits of the Islands of the Southern Pacific, and their Prehistoric Remains." Captain Riley paid particular attention to the guano deposits of the Chincha Islands, on which he had lived for a number of years. The first guano was taken from the Island in 1804, by Humboldt shipments began in 1840, and between 1850 and 1880, guano to the value of 550 millions in gold was taken from the three islands alone. The guano has been deposited by birds, and preserved because the region lies in the rainless belt, where rain is uncommon except about once in seven years. Captain Riley thinks that the marked banding of the guano denotes variation from wet to dry seasons. From the guano at the depth of 35 and 68 feet, have been taken two burial structures, containing several bodies, apparently entombed with great pomp, and showing a high state

from the 1,000 c.c. of water from each level is lodged in 20 c.c. of the formalin preservative, while the above figures are taken from the counting of 1 c.c. of such filtrate, or $\frac{1}{50}$ part of the whole litre of ocean water treated, at each level.

It is not to be assumed, of course, that this reduces the analysis of the contents of the water to a mathematical basis, as it only furnishes ground for estimates, based upon actual counts; but we do believe that it gives a true picture of the vertical distribution of certain forms at the time the samples were taken.

In notes taken in connection with the collections upon which this paper is based, Harrington says: "Tow taken in Port Townsend Harbor varied greatly on successive evenings. It was noticed after a rain that the surface water had a muddled appearance, and that the net was quickly clogged with a brown coating of *Coscinodiscus* and *Arachnodiscus*, while on other evenings comparatively few of these were to be seen. The number of medusæ varied very noticeably with the roughness of the sea, falling of rain, etc., and a strong inshore wind always brought in various organisms, such as masses of *Noctiluca*." He also states that the collection from which the plotting was made was taken at the close of a week in which there had been hardly any rain, and that in a glass jar the water was very transparent, while a few copepods could be seen in some of the samples.

The causes for the sudden appearance of a given pelagic organism and its similar disappearance, in great numbers, are very obscure, although the facts have often been observed. Whipple,* from observations in the several basins of the water supply of the city of Boston, Mass., has attempted to throw light upon the seasonal increase in certain diatoms by assigning as causes the vertical stirring up of the water, and the necessary presence of oxygen in connection with the assimilation of nitrates by the growing cells. Many interesting data have thus been brought together by him, concerning the seasonal growth of this organism in shallow fresh waters, but such conditions would with difficulty be applied to marine forms over the much greater depths here described, and it is probably true that there is more fluctuation in shallow water and at the surface than in the deeper strata. We also gather from the work of Professor John Walther,† summarizing the work relating to the depth to which light penetrates, and its various spectrum absorption, etc., that the bottom depths reached by our analysis in Puget Sound are only about half the distance to which the sun's rays can penetrate under

*Some observations on the Growth of Diatoms in Surface Water, Technology Quarterly, Vol. VII., No. 3, 1894.

†Bionomie des Meeres, Jena, 1893, p. 35.

favorable conditions, and also that the vertical sounded by us transverses a variety of colors in the water that are due to the absorption of the several elements of the light.

It may be said in general, therefore, of the vertical distribution here recounted, that the surface strata present the greatest numbers of living individuals, and furnish the most favorable, although irregular, conditions for the growth and reproduction of these organisms; but in the case of the large diatoms burdened with a large siliceous case there is a relatively rapid sinking into the strata beneath, and in other diatoms the conditions of growth seem to be well fulfilled in the lower strata. It is also true that all the forms here treated except the Copepoda are found alive throughout the whole extent of our vertical, *i. e.*, 112 fathoms deep.

We believe, moreover, that this is the lowest depth to which this method of quantitative estimate has been carried, and that, as it gives analysis of water over such considerable depths, it calls attention to them as recipient areas for material in process of sedimentation as well as for conditions of life and growth in an environment quite removed from the surface.

We refer, in closing, with gratitude to the coöperation of Professor H. F. Osborn, by whose provision in the Zoölogical Expedition these collections were made possible. The identification of the diatoms was kindly aided by the photographs made by Mr. O. E. Schaffer, of Port Townsend, Washington, who furnished very complete data in this respect for that locality. All the labors of procuring apparatus, collecting the materials and furnishing descriptive data referring to such work were done by the junior author of this paper, while the quantitative estimates, plottings and writing are the work of the senior author.

BIOLOGICAL DEPARTMENT, WILLIAMS COLLEGE,
WILLIAMSTOWN, MASS., Nov. 20, 1897.

[Zoölogy of Puget Sound. Columbia University Contributions No. 7.]

## THE MATURATION AND FERTILIZATION OF THE EGG OF ARENICOLA MARINA.

BY C. M. CHILD.

The material forming the basis of this paper was collected during the summer of 1896, at Puget Sound, by Mr. N. R. Harrington, of the Columbia University Expedition. My thanks are due him for the opportunity of examining the material, and I take this occasion to express my obligation.

of the view that this disintegration is a part of the normal history of these structures, for a little later there is no trace of asters or spindles in the egg.

The pronuclei increase still further in size and show the chromatin in the form of a long thread. Meanwhile they approach each other. At a stage when they are near together, but before contact occurs, they are seen to be surrounded by an area in which the cytoplasm possesses a reticular structure. Outside of this and about it as a center a distinctly radiate arrangement of the cytoplasm is found. This is evidently not an aster, although its rays are probably perfectly similar in nature to astral rays. There is no trace of centrosome or true aster in the egg. The radiate arrangement of the cytoplasm appearing at this time is evidently the expression of some activity within the egg. It may perhaps be due to the absorption of liquid from the cytoplasm by the pronuclei in their rapid growth, and decrease in density. This may result in cytoplasmic contraction, the network being stretched in a radial direction. The reticular appearance of the region about the pronuclei may indicate that there is an accumulation of liquid there.

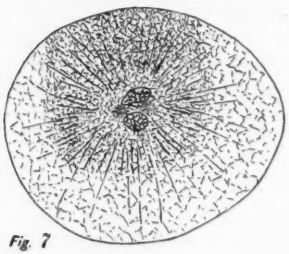


*Fig. 7*

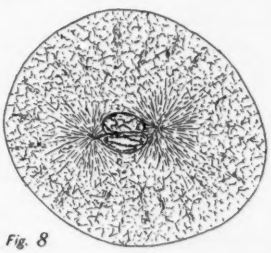


*Fig. 8*

Now, at the stage shown in Fig. 7, just before the pronuclei come into contact, two extremely minute asters appear in the plane of copulation, one on either side of the pronuclei. These are clearly seen to have no relation to the large radiation just mentioned. At first it is impossible to distinguish any definite centrosome at their centers, but they grow rapidly and a centrosome soon becomes visible in each, though at first extremely small. The two pronuclei now lie in contact. They are still larger than before, and the chromatin threads are clearly visible.

The two asters become large and distinct, and some of the rays are seen to end in the nuclear membrance of both pronuclei. This stage is shown in Fig. 8. The pronuclei are elongated in

the direction of the line connecting the two asters, as if pulled out by the fibers attached to the membrane. In other sections it can be seen that there are fibers connecting the two asters, *i. e.*, spindle fibers. In all cases one aster is slightly smaller than the other.

Near the periphery of the egg are seen in Fig. 8 the last traces of the disintegrating rays, which are so conspicuous in Fig. 7. As the new asters increase in size these rays break down, and the cytoplasm once more arranges itself in the form of rays about the two centrosomes.

The pronuclei do not fuse, but the membranes disappear, apparently going to form at least a portion of the spindle-fibers. The chromosomes arrange themslves about the equator of the now large and distinct spindle, and the first cleavage begins. Dissimilarity in size of the two asters are seen throughout the cleavage.

The phenomena recounted have a direct bearing upon several questions of considerable importance. They show, first, that the centrosome is not permanent, at least not in its ordinary form. It is at present impossible to prove that the centrosome which appears in the "male" aster did not enter with the spermatzoön and exist for a time in some non-tingible form. It is difficult, however, to deny the possibility of its formation, together with that of the aster, from the egg-cytoplasm as the result of some stimulus furnished by the sperm. Again, the centrosomes which result from its division may, in spite of their seeming disappearance, still exist in some form and reappear as the centrosomes of the cleavage spindle. The impossibility of distinguishing any centrosome in the cleavage-asters in their earlier stages, and the minuteness of the centrosomes, when they do appear, would seem, however, to indicate a new formation. If the cleavage centrosomes are the same as those which accompany the sperm-head and then disappear, the difference in size of the two "male" asters observed in some cases may be connected with the difference in size of the cleavage-asters. It seems, at any rate, that the difference in size of the cleavage-asters anticipates and indicates the difference in size of the first two cells of cleavage, since the cleavage is unequal. If now the continuity of the centrosomes were proven, and if the difference in size of the "male" asters is of general occurrence, which is by no means certain, then we might, perhaps, be justified in assuming that the unequal first cleavage is determined as unequal when the "male" aster divides. This is a point of great interest and requires further investigation. I am inclined, however, to regard the cleavage-centrosomes as new formations and as not related to the "male" centrosomes.

PLATE IV.

*Edestus LeConteï*, n. s. From the Carboniferous of Nevada. See p. 62.
Fig 1 A, is small figure below main cut.

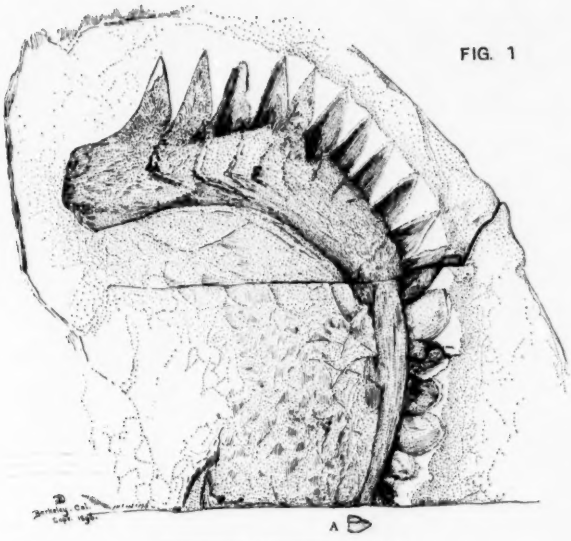


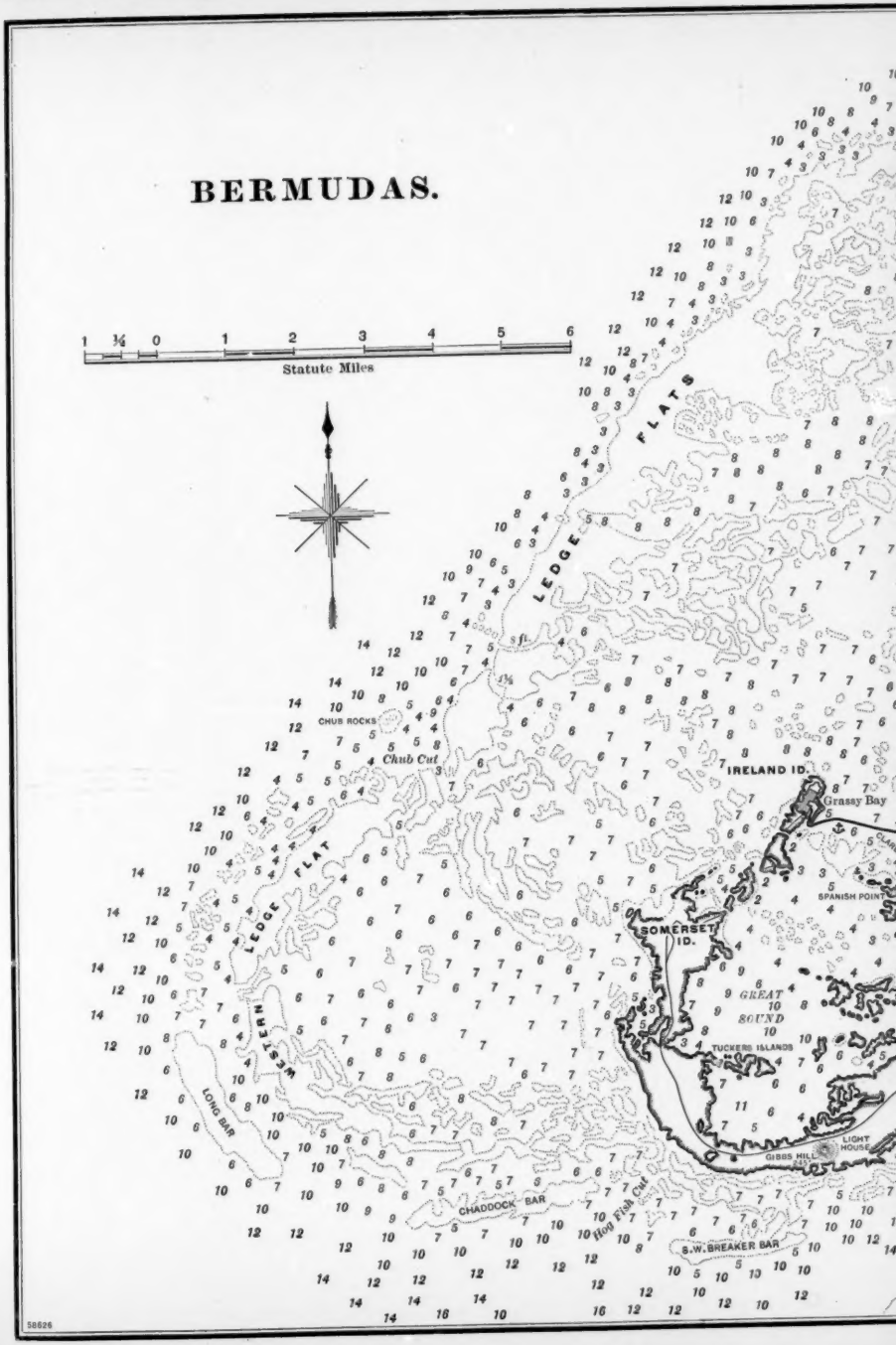
FIG. 1

EDESTUS LECONTEI, N. S.

## PLATE VIII.

Map of the Bermuda Islands, reproduced from Plate X. (misprinted XI.) of "The Atlantic," Vol. 1, p. 272, of the Voyage of the Challenger, by Sir C. Wyville Thomson.

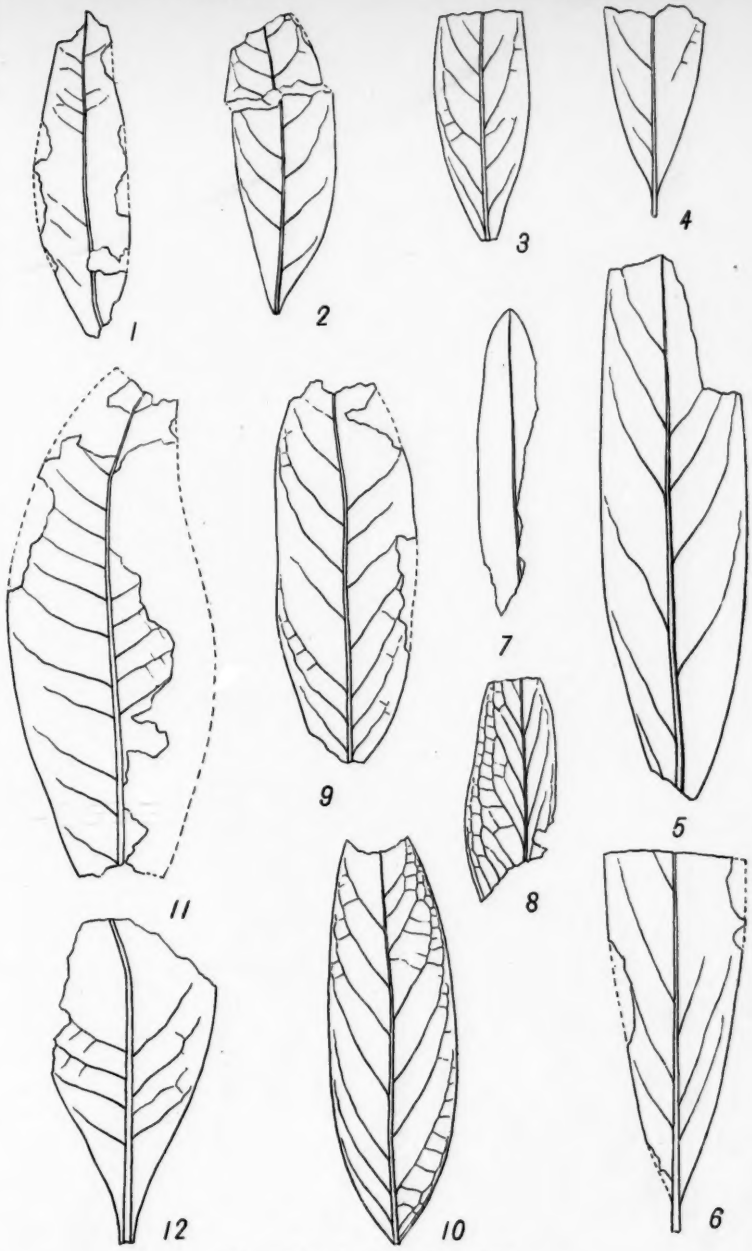
The plate illustrates the paper by J. J. Stevenson, pp. 96-124, on "Notes on the Geology of the Bermudas."


BERMUDAS.
1 ½ 0 1 2 3 4 5 6
Statute Miles
LEDGE FLATS
CHUB ROCKS
Chub Cut
IRELAND ID.
Grassy Bay
SPANISH POINT
SOMERSET ID.
GREAT SOUND
TUCKERS ISLANDS
GIBBS HILL LIGHT HOUSE
WESTERN LEDGE FLAT
LONG BAR
CHADDOCK BAR
Hog Fish Cut
S.W. BREAKER BAR
58626

## PLATE XIII.

Illustrating paper by Arthur Hollick, entitled "The Cretaceous Clay Marl Exposure at Cliffwood, N. J.," pp. 128–136.

FIGS. 1, 2. *Sapindus apicalutus* Vel.
FIGS. 3. 4. *Salix Meekii* Newb.
FIGS. 5, 6. *Laurus plutonia* Heer.
FIG. 7. *Banksia pusilla* Vel.
FIG. 8. *Rhamnus inæquilateralis* Lesq.
FIGS. 9, 10. *Quercus* (?) *Novæ-Cæsareæ* Hollick.
FIGS. 11, 12. *Quercus Morrisoniana* Lesq.




Flora of the New Jersey Clay Marl.

## PLATE XVI.

Illustrating the paper of N. R. Harrington, pp. 214–222.

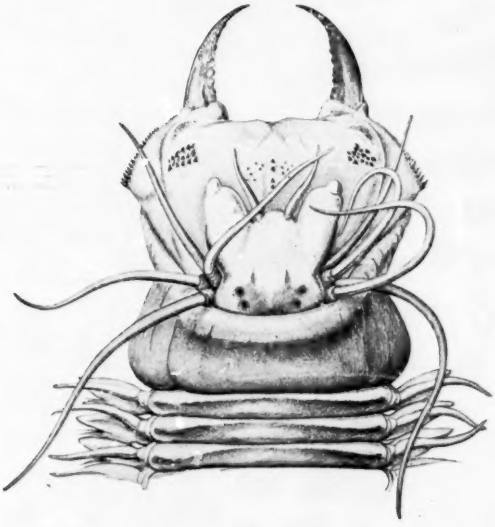
FIG. 1. *Eupagurus alaskensis* (Benedict), with commensal *Nereis cyclurus* n. sp., inhabiting *Lunatia* shell.

FIG. 2. Lower coils of *Lunatia* shell, inhabited by hermit-crab, broken away, showing *Nereis cyclurus* in its normal retreat.

FIG. 3. Head and anterior somites of *Nereis cyclurus* n. sp. This drawing was made by Mr. J. H. McGregor. Figures 1 and 2 are reproduced from photographs.

1

2



3

## PLATE XXII.

Illustrating posthumous paper by J. S. Newberryy, entitled, "New Species and a new Genus of American Palæozoic Fishes, etc." Edited by BASHFORD DEAN. pp. 282–304.

FIG. 1. *Cladodus splendens*, n. s. Kinderhook Group, Burlington, Iowa. p. 284.

FIGS. 2, 2 a. *Cladodus mortifer*, n. s. Lower Coal Measures. near Newport, Ind. p. 285.

FIG. 3. *Oracanthus vetustus*, St. J. & W. Kinderhook Group, (Burlington, Iowa.) p. 285.

FIG. 4. *Oracanthus pugniunculus*, St. J. & W. St. Louis Limestone, Alton, Ill. p. 288.

FIG. 5. *Oracanthus lineatus*, n. s. (St. Louis Limestone ? *Ed.*) p. 289.

FIG. 6. *Ctenacanthus depressus*, n. s. Kinderhook Group, Le Grand, Ia. p. 291.

FIG. 6

## PLATE XXIV.

Illustrating posthumous paper by J. S. Newberry, entitled, "New Species and a new Genus of American Palæozoic Fishes, etc." Edited by BASHFORD DEAN. pp. 282-304.

FIGS. 1-7. *Deltodus complanatus* N. & W. (Burlington Group—*Ed.*). p. 298.

FIGS. 8-11. *Deltodus spatulatus* N. & W. (Burlington Group—*Ed.*). p. 299.

FIG. 12. *Sandalodus ellipticus* n. s. Kinderhook Group, Le Grand, Ia. p. 299.

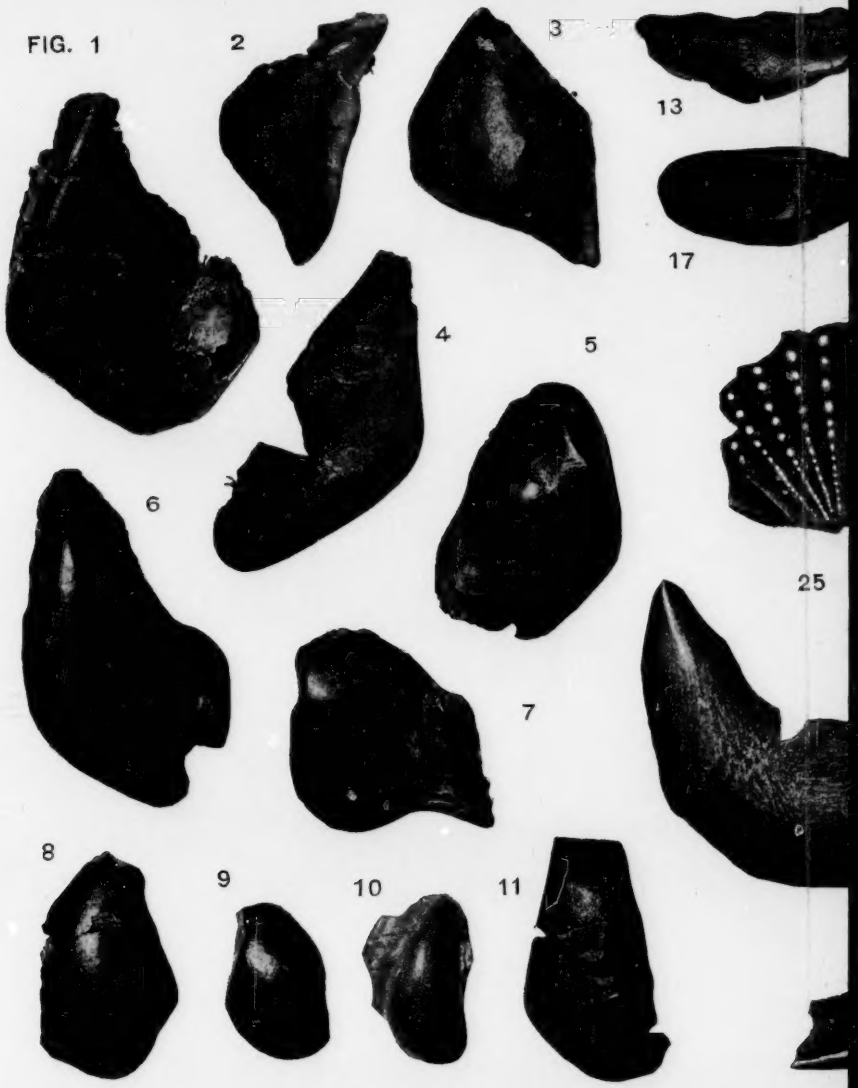
FIGS. 13-23. *Psephodus* (*Helodus*) *politus*, n. s. Burlington Limestone. p. 301.

FIG. 24. *Helodus coxanus*, n. s. Keokuk Limestone, Keokuk, Ia. p. 301.

FIG. 25. *Ctenodus fleisheri*, n. s. Catskill Formation, Tioga Co., Pa. p. 302.

FIG. 26. *Ctenodus* [*Sagenodus* (*Ed.*)] *angustus*, n. s. Catskill Formation, Bradford Co., Pa. p. 303.

FIG. 27-28. *Stenognathus corrugatus*, n. g. Cleveland Shales, Lorain Co., O. p. 303.

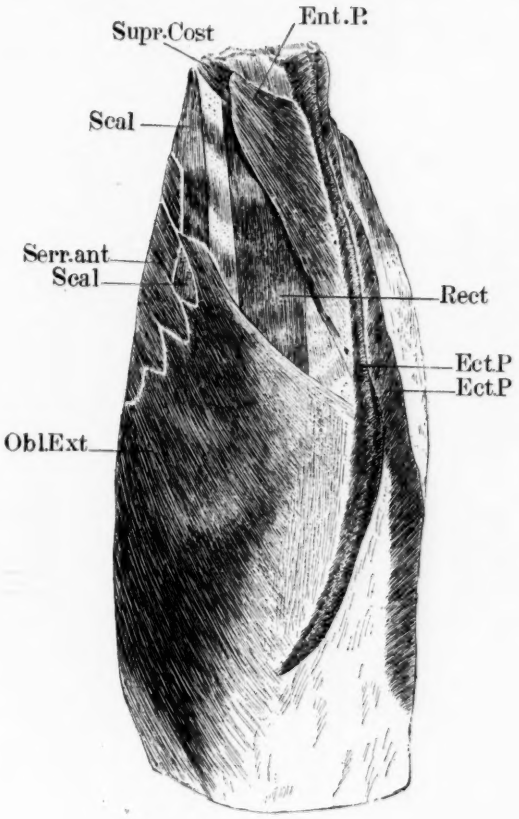



NEWBERRY. PALAEZOIC FISHES. DELTODUS, SANDALODUS,

## PLATE XXXIV.

Illustrating paper by Geo. S. Huntington, entitled, "Contribution to the Myology of *Lemur bruneus*," pp. 335–363. For explanations of abbreviations see title to Plate XXVIII.

FIG. 1. Muscles of Trunk ; forelimb detached ; right side.


Supr.Cost
Ent.P.
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Serr.ant
Scal
Rect
Ect.P
Ect.P
Obl.Ext

Exhibited in this instance in connection with the investigation of the action of "Magnetic circuit breakers" as used in electric light and power circuits.

6. Induction Coil with 20" Spark. Crookes tubes for use in making Röntgen ray photographs. Photographs of the pelvis and thorax. An early arc lamp mechanism. Exhibited by M. O'Connor.

7. One Horse-Power Self-Starting Synchronous Motor. Starts by connecting one side of the armature and one winding on the field as a series motor on an alternating current circuit. When the proper speed has been attained, a switch is thrown, thereby changing the alternating current to the alternating current side of the armature and making the motor a synchronous one. The former side of the armature now generates a direct electromotive force, which sends current through the field windings, thus exciting them.

8. Porcelain Insulator as used on the Niagara-Buffalo transmission line to support wires between which exists a pressure of 10,000 volts. Nos. 7 and 8 are exhibited by the Electrical Engineering Department, Columbia University.

9. Induction Coil and Circuit Breaker for generation of Röntgen rays. Exhibited by M. I. Pupin.

10. Special Crookes Tubes and Specimens of German Tubes for X-ray Work. Igniter for gas engines. Exhibited by Max Osterberg.

11. Novel Arc Light Carbon Carrier.

12. One of the two Original Henry Induction Coils.

Nos. 11 and 12 are exhibited by R. Ogden Doremus.

# F

# ETHNOLOGY AND ARCHÆOLOGY.

IN CHARGE OF FRANZ BOAS AND M. H. SAVILLE.

1. SKELETON as found in a burial mound near Mays Lick, Mason County, Kentucky. Collected and prepared by Harlan I. Smith.

2. MODEL of an ALTAR MOUND containing human burial. North Fork Works near Chillicothe, Ohio. Modelled by Harlan I. Smith.

   Nos. 1 and 2 are from the collections of the American Museum of Natural History.

3. ARCHÆOLOGICAL SPECIMENS FROM NEW YORK CITY. Collected and exhibited by W. L. Calver.

4. CODEX VATICANUS, No. 3773. Chromo-photographic reproduction of the celebrated pre-Columbian Mexican manuscript preserved in the Vatican Library, Rome, published in 1896 by the Duke of Loubat. Exhibited by M. H. Saville.

5. CODEX LEGISLATIF. Carbon reproduction of the unpublished Mexican manuscript, preserved in the Library of the Chamber of Deputies, Paris. Exhibited by the American Museum of Natural History.

6. REPRODUCTION OF THE UNPUBLISHED MEXICAN MANUSCRIPT OF THE FLORENCE LIBRARY, PART OF THE HISTORY OF MEXICO, BY FATHER SAHAGUN. Exhibited by the Peabody Museum of Harvard University.

7. ARCHÆOLOGICAL SPECIMENS ILLUSTRATING RECENT DISCOVERIES AT THE RUINS OF OMITLAN, STATE OF GUERRERO, MEXICO. Collected by William Niven. From the collection of the American Museum of Natural History.

*f*. Instrument for the study of fatigue (Mosso).
*g*. Instrument for accuracy of extent of movement (Cattell).
*h*. Instrument for right and lelt movements (Jastrow).
*i*. Instrument for time of movement; with chronoscope (Cattell).

## H

## GEOLOGY.

In Charge of J. F. Kemp.

1. Suite of Selected Specimens for Lecture-Room Use, mostly dynamical in nature.

   Exhibited by Prof. R. E. Dodge, Teachers College.

   *a*. Slab of Cambridge Slate, to show faulting parallel to the bedding.
   *b*. Obsidian from the Lipari Isles, showing conchoidal fracture.
   *c*. Large sand-blasted pebble from Cape Cod, Mass.
   *d*. Slab of slate from Slate Island, Boston Harbor, to show topographical effects of faults.
   *e*. Specimen of Roxbury conglomerate, showing particularly large pebbles.
   *f*. Banded and faulted Dakota Sandstone.

2. Suite of Specimens Showing the Contact Zone of the Sierra Tlayacac, State of Morelos, Mexico, and illustrating a remarkable case of recrystallization of a sedimentary rock by contact with eruptive masses. The coarser and finer grained representatives of the darker (earlier) eruptive and lighter (later) intrusion are shown. The darker was shattered by the disturbance attending the eruption of the later rock. Exhibited by Prof. A. C. Gill, Cornell University, Ithaca, N. Y.

3. Mountain-building Studies.

   Numbers 3, 4, and 5 are exhibited by the Laboratory

of Experimental Geology, Harvard University, through T. A. Jaggar, Jr., the m. ker and deviser of the studies.

*a*. Diagrams showing compression chest with which experiments were made.

*b*. Four diagrams illustrating influence of rate of compression of models E, F, G.

*c*. Three models illustrating the influence of initial variations; B, C and D.

4. GLACIAL DELTA STUDIES.

*a*. Three mounted diagrams showing stages of experiment.

*b*. One unmounted diagram showing cross section of delta.

*c*. One unmounted diagram showing special study of water level in relation to formation of delta.

5. RIPPLE MARK STUDIES.

*a*. Four plates showing influence of amplitude by oscillation.

*b*. One plate showing cross ripples.

6. SAND-BLASTED PEBBLES.

*a*. Limestone pebble, engraved and polished by the drifting sand of the desert, Wadi Amara, Arabia Petrea.

*b*. Pebble of snowy gypsum, with similarly engraved surface, Wadi Amara, Arabia Petrea.

The above were collected by Dr. Bolton. They may be compared with Exhibit 1c. Exhibited by Dr. A. A. Julien, Columbia University, and H. Carrington Bolton, Washington, D. C.

7. A SERIES OF COPPER ORES AND WALL-ROCKS, from Butte, Mont., collected June, 1896, by J. F. Kemp, by whom they are exhibited. The ores are chalcocite, enargite, bornite, chalcopyrite and tetrahedrite and all contain silver. Rhyolite is an important rock in the neighborhood of the veins, and light-colored granite is not far away. Silver mines also occur in the camp, with an entirely different set of minerals from the copper. A few of these are shown, with their gangue of rhodochrosite. The specimens illustrate also the quartz ledges that constitute the outcrops of the veins.

*c*. From Willards' Ledge Quarry, Burlington, Vermont, cutting the Potsdam sandstone. As shown in the sketch exhibited, the dike was about 3 feet wide, but occupied two parallel wedge-shaped cavities.

A few other dikes of interest, from the same region, are shown, with appended notes.

# I

# MINERALOGY.

In Charge of George F. Kunz.

Mineralogical Apparatus recently acquired by the Mineralogical Department of Columbia University.

1. Fuess Microscope with simultaneously rotating nicols.
2. Seibert Lithological Microscopes; A, 11.
3. Klein's Universal Rotation Apparatus for Crystals, especially for determination of optical principal sections and measurement of angles between optic axes in liquids of high index of refraction.
4. Klein's Universal Rotation Apparatus for Thin Sections, especially for exact orientation of haphazard sections and determination of their optical constants.
5. Traube's Apparatus for darkening field of goniometer.
6. Laspeyere's Burner for monochromatic light.
7. Lamp for goniometer.
8. Attachment for Converting Fuess goniometer into an axial apparatus.
9. Attachment for Deliquescent Crystals, Fuess goniometer.
10. Von Federow Mica Wedges for measuring strength of double refraction.

11. MODELS OF POSITIVE AND NEGATIVE uniaxial indicatrices and of the biaxial indicatrix with sections normal and oblique to optic axes.

12. APPARATUS FOR ELECTRICAL HEATING on stage of microscope.

13. TOTAL REFLECTOMETER. Moses-Weinschenck.

14. PHOTOGRAPHIC CAMERA for microscope.

Nos. 1 to 14 exhibited by Prof. A. J. Moses, of Columbia University.

15. BARITES. From the Bad Lands of South Dakota. These barites occur on calcite in the centre of septaria, which are often nine feet in diameter. Collected by Professor E. H. Babour.

16. FIBROUS GYPSUM. From the Fort Benton clays, near Newcastle, Wyo. Collected by H. Ries.

17. SYLVANITE CRYSTALS (altered). From Anaconda Mine, Cripple Creek, Colo.

18. SILVER ORE (Polybasite) on Barite. From Aspen, Colo. On account of the peculiar manner in which this mineral occurs, it has been called "X-ray ore."

19. APATITE and PYROXENE in Calcite. Bradley Mines, Orange County, N. Y.

Nos. 15 to 19 exhibited by Heinrich Ries.

20. COVELLITE. From the copper mines at Butte, Montana. Several pieces obtained about 1,000 feet below the surface. Is a brilliant, blue copper sulphide, CuS, and is a rather rare mineral.

21. ANDALUSITE. Pink prisms one to two inches square; from a great pegmatite vein that had been opened for tin ores in the Black Hills, S. D.

22. ALLANITE. From Mineville, N. Y. Recent discoveries of well bounded crystals that occur in a pegmatite vein, with orthoclase and quartz.

23. ZIRCONS. From a pegmatite vein in the iron mines at Mineville, N. Y.

*a*. Mounted Skeleton of *Hoplophomus primævus* Leidy. An extinct Saber Tooth Tiger from the White River Oligocene of South Dakota. Discovered by Dr. J. L. Wortman. Mounted by Adam Herman.

*b*. Disarticulated Skeleton of *Hoplophomus primævus* Leidy. A remarkably perfect skeleton found by Mr. I. A. Peterson in the Bad Lands of the White River Oligocene, South Dakota.

*c*. Mounted Skeleton of *Palæosyops palodosos* Leidy. One of the ancestral Titanotheres from the Bridger Eocene of Wyoming. Found by Dr. J. L. Wortman and mounted by Adam Herman.

*d*. Cast of Skull and Lower Jaws of *Diplacodon*, the Uinta Eocene ancestor of *Titanotherium*. Showing an early stage in the development of the horns.

*e*. Part of Skeleton of *Euprotogonia puercensis* Cope. One of the earliest of the hoofed mammals known. From the Upper Puerco (Torrejon Beds) of New Mexico. Found by Mr. Walter Granger of the Expedition of 1896.

*f*. Skull and lower jaws of *Coryphodon* sp. One of the early Eocene forerunners of the Mintacheres. From the Wasatch Eocene of the Big Horn Basin, Wyoming. Expedition of 1896.

*g*. Lower jaw of *Dissacus saurognathus*, a new species of Creodont or ancient flesh-eater from the Upper Puerco (Torrejon Beds) of the San Juan Basin, New Mexico. Found by Mr. Barnum Brown, of the expedition of 1896.

*h*. Specimens illustrating a new and primitive suborder of ancestral Edentates (Ganodonta). The origin of the great order Edentata which is principally South American in its distribution, has remained a puzzle to zoölogists until the discovery during the past year of a large part of the skeletal structure of one of the members of this group in the Upper Puerco (Torrejon Beds) of New Mexico. This discovery indisputably establishes the fact that the

Ganodonta gave rise to the Edentata and fixes the origin of this important order of living mammals in North America, in the earliest Eocene times.

I. Family Stylinodontidæ.

1. Parts of the skeleton of *Hemiganus atariidens* Cope. From the base of Puerco. Cope collection.
2. Various parts of the skeleton of *Psittacotherium multifragum* Cope. From the Upper Puerco (Torrejon Beds), mainly from the expedition of 1896. Discovered by Dr. J. L. Wortman and Barnum Brown.
3. Lower jaws of *Calamodon simplex* Cope, from the Wasatch Eocene of the Big Horn Basin, Wyo. Cope collection.
4. Molar tooth of *Stylinodon cylindrifer* Cope, from the Wind River Eocene, Wyo. Cope collection.
5. Drawings of *Stylinodon minus* Marsh, from the Bridger Eocene of Wyoming.

II. Family Conoryctidæ.

1. Parts of the skeleton of *Onychodectes tissonensis* Cope, from the Lower Puerco of New Mexico.
2. Parts of the skeleton of *Conoryctes comma*, Cope, from the Upper Puerco (Torrejon Beds), New Mexico.

*i.* Exhibition of water colors illustrating the extinct vertebrates of North America, continuing the series which was exhibited last year by Charles Knight;

1. The Restoration of *Mastodon americanus.*
2. *Paleosyops paludosus.*